DOCUMENT RESUME

ED 216 035 TM 820 197

AUTHOR Cox, Brenda G.; Folsom, Ralph E., Jr.
TITLE An Empirical Investigation of Alternative Item Nonresponse Adjustment Procedures. National Longitudinal Study, Sponsored Reports Series.
INSTITUTION Research Triangle Inst., Durham, N.C. Center for Educational Research and Evaluation.
SPONS AGENCY National Center for Education Statistics (ED), Washington, DC.
REPORT NO RTI/0884/52-071
PUB DATE Sep 79
CONTRACT OEC-0-73-6666
NOTE 275p.; For related document see TM 820 198. Contains small type in computer printout sections.

EDRS PRICE MF01/PC11 Plus Postage.
DESCRIPTORS *Graduate Surveys; Item Analysis; *Longitudinal Studies; *Statistical Analysis; *Statistical Bias
IDENTIFIERS Empirical Analysis; Error Analysis (Statistics); *National Longitudinal Study High School Class 1972; *Response Rates (Questionnaires)

ABSTRACT

Using an empirical investigation of alternate item nonresponse adjustment procedures in a National Longitudinal Study (NLS) of missing and faulty data, it is indicated that in some cases imputation can reduce the accuracy of survey estimates. A National Sample of the high school class of 1972 is designed to provide statistics on students moving into early adulthood. The bias resulting from nonresponse and response errors is evaluated using hot deck and weighting class adjustment techniques to analyze telephone followups after the original response to 20 critical survey items. Regarding bias variance, comparison is made with estimates when no imputation or editing techniques are used. Item nonresponse imputation and adjustment procedures are presented with the design of the experimental data base. Bias, variance and mean square error estimations, and the results of the imputation comparisons are presented. The investigation of more complex statistical analyses is suggested. A bibliography is presented with appendices including an executive summary, data coding of the study, the followup questionnaire, statistical comparisons, and formulas for the standard errors program in the survey. (CM)

RTI/0884/52-07I

NATIONAL LONGITUDINAL STUDY
SPONSORED REPORTS SERIES

AN EMPIRICAL INVESTIGATION OF ALTERNATE ITEM NONRESPONSE ADJUSTMENT PROCEDURES

by

Brenda G. Cox
Ralph E. Folsom, Jr.

Center for Educational Research and Evaluation
Research Triangle Institute
Research Triangle Park, N.C. 27709

Prepared for
National Center for Education Statistics
Education Division
U.S. Department of Health, Education, and Welfare

William B. Fetters, Project Officer

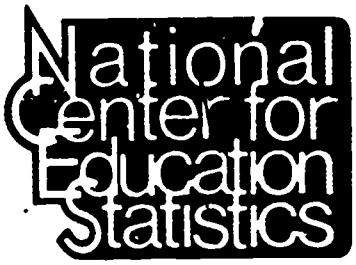
U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Patricia Roberts Harris, *Secretary*

Education Division
Mary F. Berry, *Assistant Secretary for Education*

National Center for Education Statistics
Marie D. Eldridge, *Administrator*

NATIONAL CENTER FOR EDUCATION STATISTICS

"The purpose of the Center shall be to collect and disseminate statistics and other data related to education in the United States and in other nations. The Center shall... collect, collate, and, from time to time, report full and complete statistics on the conditions of education in the United States; conduct and publish reports on specialized analyses of the meaning and significance of such statistics; . . . and review and report on educational activities in foreign countries."—Section 406(b) of the General Education Provisions Act, as amended (20 U.S.C. 1221e-1).



This report was prepared for the National Center for Education Statistics, Education Division, under contract No. OEC-0-73-6666 with the U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects are encouraged to express freely their professional judgment. This report, therefore, does not necessarily represent positions or policies of the Education Division, and no official endorsement should be inferred.

September 1979

FOREWORD

The National Longitudinal Study (NLS) of the High School Class of 1972 is a large-scale long-term survey effort supported by the National Center for Education in the Department of Health, Education, and Welfare (DHEW). Broadly stated, NLS is designed to provide statistics on a national sample of students as they move out of the American high school system into the critical years of early adulthood. Data have been gathered and colligated from several sources, coded and edited for analysis purposes, and stored on magnetic computer tapes for future access. The current tapes contain base-year (1972) survey data, collected by the Educational Testing Service, integrated with first follow-up (1973), second follow-up (1974), and third follow-up (1976) survey data, collected by the Research Triangle Institute (RTI). This tape package is augmented periodically as data from subsequent follow-up surveys become available.

The merged NLS data file represents a rich and complex source of information. It contains important and timely data of potential use to a broad spectrum of educators, researchers, policy analysts, and decision makers. Preparation of this data file for general use by such a large and diverse set of users was a difficult task. Decisions as to the kind and extent of data editing that needed to be performed were by no means clear-cut. In conflict were the need to maintain a faithful record of the original raw data--including respondent errors and inconsistencies--versus the need to provide a straight-forward set of data for the typical researcher. The former need was given more importance in the approach to editing the NLS data file. That is, it was felt that editing, recoding, imputation, or other data transformation procedures should be minimized so as to limit tacit assumptions about the respondents or subjective interpretation of the data that would be required for these procedures. Any imputations or modification of the original data might be considered "biased" by other investigators. Where imputations are concerned, researchers should be free to set data standards in accordance with their specific needs. Thus, the data transformation procedures that were used were directed toward making the data available in a consistent and useful format that would preserve as accurately as possible the original responses of the study participants.

The file processing that was performed involved extensive verification, cleaning, and supplementary coding of the original data. Editing transformations were limited to verifying that respondents followed the written instructions and routing patterns in the questionnaire. If either type of instruction was violated, then supplementary codes were inserted in the data to indicate the location and nature of the violation. The extent and details of the editing are discussed in the NLS Users Manual (Levinsohn, et al, 1978).

It would have been possible to provide another level of editing. Responses could have been edited with respect to the content of the question and with respect to the interrelations of sets of questions. But this kind of editing requires some guidelines and is usually directed by the particular set of hypotheses under investigation. Since the data file is designed for such a broad range of investigators, and in the interest of timeliness, it was decided that any further editing must be left to the discretion of the analyst. This decision creates some additional work for the user, but it allows full access to all the original detail in the data file. No analyses have been prohibited by preprocessing or prior summarization of the data.

The decision to produce the data file in this format places some additional responsibility on the user. Since little simplification of the data has been done, the analyst must exercise care in using the data file. The NLS data base is large and complex. The routing patterns in the instruments and the fact that data have been collected at different points in time require that the analyst view the data base holistically. Many of the individual items are not well suited to independent analysis. Moreover, it is necessary to consider the interdependent nature of such items and to study the patterns of response to those items. Given consideration of these cautions and careful study of the documentation provided in the Users Manual, the NLS data file will serve as the rich source of information that it was designed to provide.

In this empirical investigation of alternate item nonresponse adjustment procedures, the nature of missing and faulty data was investigated based upon the original responses to 20 critical items on the third follow-up instrument. Since these critical items were subject to telephone follow-up to correct missing and faulty data, the bias resulting from nonresponse and response errors could be evaluated. Further, two nonresponse imputation procedures were tested on this experimental data set of original responses to the 20 critical items and the resulting estimates of means and proportions compared

with respect to their bias, variance, and mean square error to the estimates obtained when no imputation or editing procedure is used. One of the most striking findings of the study is that in some cases imputation can reduce rather than increase the accuracy of survey estimates. It is hoped that the results of this investigation will provide guidance to the user of the NLS data base in dealing with missing and faulty data.

An executive summary highlighting the major findings of this investigation is presented in Appendix A.

Absalom Simms, Acting Director
Division of Multilevel Education Statistics
NCES

Elmer F. Collins, Chief
Longitudinal Studies Branch
NCES

ACKNOWLEDGEMENTS

The authors would like to acknowledge the advice and assistance received from Research Triangle Institute staff members during the course of this study. Significant amounts of time and effort were expended by Ms. Susan M. Kellenberger and Ms. Janet C. Greenblatt in creating data files for this investigation, developing imputation software, and performing the computer analyses. The extraction of the pre-telephone data was performed under the direction of Ms. Mary Artz, supervisor for NLS data editing, who also gave valuable advice concerning the sources of error in the NLS data base. The interest and encouragement provided by Dr. Jay Levinsohn, NLS Project Leader, is appreciated. The expert typing and editing of Ms. Judy Hackworth, Ms. Laurine Johnson, Ms. Susan Jones, and Ms. Pam Rigsbee contributed to the overall quality of this final report. In addition to the in-house staff, the authors would like to acknowledge the thoughtful and meticulous review of the report given by Mr. William Fetters of the Longitudinal Studies Branch in the National Center for Education Statistics.

CONTENTS

TABLES

I. INTRODUCTION

In 1968 the National Center for Education Statistics (NCES) conducted a survey to determine the specific data needs of educational policymakers and researchers. Respondents to the survey expressed a need for data that would allow comparisons of student educational and vocational experiences with later outcomes. This finding provided the impetus for NCES to begin planning for the first of an intended series of national longitudinal studies.

In April 1970 a number of prominent educational researchers and administrators met with interested Federal officials in Washington, D. C. The National Longitudinal Study of the High School Class of 1972 (NLS) reflects their guidance and the interests and data needs of a number of United States Office of Education (USOE) agencies: the Office of Planning, Budgeting, and Evaluation; the Bureau of Postsecondary Education; the Bureau of Occupational and Adult Education; the Bureau of Programs for the Handicapped; as well as the National Center for Education Statistics. Four advisory committees provided guidance in the planning and implementation of the survey. One committee was composed of research experts and representatives of various educational organizations; two others were made up of officials of State education agencies; and the fourth, an internal USOE committee, represented the data needs of the various offices and bureaus of the U. S. Department of Health, Education, and Welfare (DHEW).

The primary purpose of NLS is the observation of the educational and vocational activities, plans, aspirations, and attitudes of young people after they leave high school and the investigation of the relationships of this information to their prior educational experiences and biographical characteristics. Ultimately, the study will allow a better understanding of the development of students as they pass through the American educational system and of the complex factors associated with individual educational and career outcomes. Such information is essential as a basis for effective planning, implementation, and evaluation of Federal policies and programs designed to enhance educational opportunity and achievement and to upgrade occupational attainments and career outcomes.

Following a rather extensive period of planning, which included the design and field test of survey instrumentation and procedures, a full-scale

survey was initiated in the spring of 1972. The sample design called for a deeply stratified national probability sample of 1,200 schools with 18 seniors per school, school size permitting. The resulting base-year sample of 19,144 students from 1,009 high schools provided base-year data on up to 3 data collection forms--a Test Battery (TB), a Student Record Information Form (SRIF), and a Student Questionnaire (SQ). The key form, the SQ, was completed by 16,683 seniors.

The first follow-up survey began in October 1973 and ended in April 1974. Added to the base-year sample were 4,450 1972 high school seniors from 257 additional schools that were unable to participate earlier. This brought the total first follow-up sample to 23,451 potential respondents. First follow-up forms were mailed to 22,654 students. There were 21,350 sample members who completed a First Follow-Up Questionnaire, 69 percent by mail and 31 percent by personal interview. Of the 16,683 seniors who completed a base-year Student Questionnaire, 15,635 took part in the first follow-up survey--a sample retention rate of 93.7 percent. Participants were asked where they were in October 1973 and what they were doing with regard to work, education, and/or training. Similar information was requested for the same time period in 1972 to facilitate tracing of progress since leaving high school and to define the factors that affect that progress.

The second follow-up survey began in October 1974, and was completed in April 1975, with forms sent to 22,364 potential respondents. There were 20,872 sample members who completed a Second Follow-Up Questionnaire, 72 percent by mail and 28 percent by personal interview. Of the 21,350 persons who completed a First Follow-Up Questionnaire, 20,194 (94.6 percent) also responded to the second follow-up survey.

The third follow-up survey began in October 1976 and ended in May 1977. Questionnaires were mailed to the last known addresses of the sample members whose addresses appeared sufficient and correct and who had not been removed from active status by prior refusal, reported death, or other reasons. Some 20,092 sample members completed a Third Follow-Up Questionnaire: 80 percent by mail and 20 percent by personal interview. The overall response rate was approximately 92 percent of the initial 21,807 mailouts. The retention rate of second follow-up respondents was 93.9 percent, and the retention rate of those sample members who completed all 3 previous student instruments was 94.7 percent.

In the National Longitudinal Survey (NLS) follow-up studies, a planned sequence of reminder postcards, additional questionnaire mailings, reminder mailgrams, and personal interviews contributed to the high instrument response rates that were obtained. NLS uses a weighting class procedure based upon classifier variables obtained from prior data collections to adjust sampling weights for instrument nonresponse.

A more difficult type of nonresponse to deal with, especially in a mail survey such as NLS, is that of item nonresponse. A large number of the questionnaires that are returned have one or more blank items. The level of item nonresponse depends on the type of question and the information being solicited. For example, categorical questions typically have a smaller rate of nonresponse than quantitative questions. Of the items examined in this investigation, the two items requesting information on family income had the largest rate of nonresponse with approximately 12 percent of the incoming questionnaires having missing responses. Associated with the problem of item nonresponse is that of inconsistent or invalid responses and violations of routing patterns (often referred to as skip patterns). This is an obvious source of bias which must also be considered before the data is analysed. For categorical questions, inconsistencies can represent a greater source of bias than nonresponse.

The first step in dealing with all of the above cases of item nonresponse and inconsistencies in the responses to different items may be to check the questionnaire to determine if logical imputations can be made for the missing items or inconsistent items based upon the responses to other questions. If a logical imputation cannot be made, the next step might be to recontact those who failed to answer or incorrectly answered a question. NLS designated certain items as critical questions. If an individual did not give a valid response to a critical question, then he or she was telephoned and the missing item completed or the inconsistency resolved. Obviously this is the best solution to the problem of invalid responses. However, because of the number of items on the survey instrument and the frequency of item nonresponse and inconsistencies, this procedure could not be implemented for all items. An attempt to resolve inconsistencies and obtain missing information for every item on the instrument by recontacting the individual would have defeated the economy of the mail survey. Hence, the researcher utilizing the data needs to consider whether logical editing rules are needed to resolve or discard the

inconsistent responses. Item nonresponse adjustment procedures may also be considered to adjust for the bias that can arise due to differences between characteristics of individuals who respond or fail to respond to an item.

Presently, NLS is making no adjustment for possible bias effects due to item nonresponse when computing survey estimates. That is, the sample means and proportions are the weighted respondent averages where the weights reflect the sample selection weight for the individual after adjustments are made within weighting classes for instrument nonresponse. This procedure, which does not adjust or impute for missing responses to an item, but which instead uses the estimated respondent mean, will be referred to throughout this paper as the no imputation procedure. In the following sections of this report, a review of possible item nonresponse imputation and adjustment procedures is presented and an empirical investigation of two of these that appear to be suited for NLS data is presented. This imputation study was conducted using NLS data in such a manner that the bias and variance of the resulting imputation-based estimators could be evaluated and compared to the bias and variance of the estimates produced by the no imputation procedure. The problem of resolving inconsistencies was not a part of the investigation, but the effect on the bias of survey estimates resulting from using data with inconsistencies was determined.

II. ITEM NONRESPONSE IMPUTATION AND ADJUSTMENT PROCEDURES

When an individual fails to respond to an item, there is still much available information about him contained on the questionnaire. For NLS, classifier variables such as race, sex, high school curriculum, high school grades, and parents' education are known about the item nonrespondent, as well as his responses to other items on this questionnaire and prior questionnaires. All of the following procedures divide the sample members into categories based upon information that is available for both groups: those who respond to an item and those who fail to respond. The assumption being made is that the responses of individuals within the same post-stratum cell are relatively homogeneous and that those in different cells are more heterogeneous.

A. The Cold Deck Imputation Procedure

The cold deck imputation procedure substitutes values from some previous census or survey for missing items on a questionnaire. Using this procedure, a cold deck is formulated by classifying this previous data according to the categories that are used to classify the present data set (e.g., race, sex, income, etc.). For each category that is defined, a distribution of responses is constructed based upon the older set of data. In processing the new data, when a missing response is determined for an item on a questionnaire, the weighting class to which the individual belongs is ascertained and a response is selected at random from the cold deck distribution for that weighting class. This response is then imputed (substituted) for the missing response on the questionnaire. After all the questionnaires have been processed and a cold deck value imputed for each missing response on the questionnaires, the means and variances are computed in the usual manner, ignoring the fact that an imputation procedure has been used.

An advantage of the cold deck imputation method is that missing responses can be imputed as the data are being processed. But the procedure also increases the variance to an extent not reflected in the estimated variance. Other criticisms of the cold deck imputation technique include the procedure's heavy reliance on the accuracy and currency of the older set of data with respect to the new set of data and the fact that information from the current

data is not being used for imputation purposes (Chapman, 1976). This technique is not feasible for most NLS item imputation since there is no older body of data on the same subject that could be used to create the cold deck distribution of responses for the weighting classes.

B. The Hot Deck Imputation Procedure

The hot deck imputation procedure eliminates the criticism that the current data is not being used for imputation purposes. This technique is similar to the cold deck procedure in that it allows imputation of missing responses as the data is being processed. When timeliness is an important factor as in the Census Bureau's Current Population Survey, this facet can become very important.

To use the hot deck imputation procedure, the individuals completing the questionnaire must again be divided up into categories. An initial value is determined for each category in the hot deck based upon previous data. As the new data is being processed, the category to which each individual belongs is determined. If the questionnaire being processed is complete, then that individual's responses replace the responses stored in the relevant category of the hot deck. Thus new responses are supplied for each cell of the hot deck as they appear in the data file. When a questionnaire is encountered with a missing item, the response in the same cell of the hot deck is imputed for the missing response. When all questionnaires have been processed and the missing data imputed, the means and variances are again computed in the usual manner without accounting for the effect of the imputation procedure (Chapman, 1976).

Since the hot deck technique is the most commonly used item nonresponse imputation procedure, it was decided that the quality of hot deck imputation should be assessed. One reason hot deck is used is its flexibility and the ease with which it can be implemented. However, Bailar and Bailar (1978) demonstrated that the hot deck procedure will cause an increase in the variance of sample means compared to a procedure which ignores missing values in computing item means. The magnitude of this increase in variance and the bias reduction resulting from imputation was investigated in this methodological study. Another flaw in the hot deck technique is that variance estimates cannot be obtained analytically but must be estimated using some form of pseudoreplication such as balanced repeated replication (BRR). In practice,

most users of the hot deck ignore the fact that imputation has occurred and compute the variance in the usual manner. The resulting variance will typically underestimate the true variance of the sample statistic. In this investigation, BRR estimates of variances were computed and then compared with results obtained when imputation was ignored. Other flaws in the hot deck procedure are that there is no probability mechanism attached to the assignment of missing values and that the same individual's responses may be used repeatedly to supply missing information.

C. The Weighting Class Imputation Procedure

In the present analysis of NLS data, a weighting class adjustment procedure is used to adjust for instrument nonresponse (i.e., when a questionnaire is not obtained for a sample member). Basically, the weighting class adjustment procedure assigns sample members to weighting classes based upon information available for both respondents and nonrespondents. Within these weighting classes, an individual is assigned an adjusted sampling weight. Respondents within weighting class ℓ have their sampling weight (which is the inverse of their probability of selection) multiplied by the weight adjustment factor, $WS(\ell)/WR(\ell)$, to produce the nonresponse adjusted sampling weight where $WS(\ell)$ is the sum of the sampling weights for all sample individuals in weighting class ℓ, and $WR(\ell)$ is the sum of the sampling weights of the respondents in weighting class ℓ. Nonrespondents are assigned adjusted sampling weights of zero. Sample estimates are then obtained using these nonresponse adjusted weights (Bailar, Bailey, and Corby, 1978).

Such a weighting class adjustment procedure may also be used for item nonresponse and adapted to become an imputation technique. To digress for a moment, we should mention the advantage of an imputation procedure over a weight adjustment procedure to adjust for bias due to item nonresponse. The weight adjustment procedure for instrument nonresponse requires that an adjusted weight be calculated for each respondent which is then stored on the data record for that individual. If a similar weighting class adjustment technique were to be used for item nonresponse, then a weight corresponding to every item on the survey instrument would have to be stored on each individual's data record. Considering the hundreds of items on the survey instrument, this is clearly not desirable. However, an imputation procedure would

substitute values for the missing responses according to certain criteria allowing the data to be processed in the usual manner without requiring weight adjustments for nonresponse to each item.

For quantitative data, an imputation technique equivalent to the usual weighting class adjustment procedure would be to assign the average value of the responses in a weighting class to all nonrespondents in that weighting class. For qualitative data where categories of responses are reported, this technique cannot be used. For example, a yes-no type question might be coded 1 for yes and 0 for no, but to impute the average (which might be something such as 0.2) to nonrespondents is not reasonable and also does not allow the usual tabulation of the data. To impute categorical responses, a technique was developed for this investigation that is analogous to weighting class adjustments. For each item, this "weighting class" imputation procedure first determines the weighted response option proportions from all responding members of the various weighting classes. For instance, the proportion of all respondents in weighting class ℓ who make response k could be denoted $\rho(k\ \ell)$. Next, the sum of the sample weights for the nonrespondents who belong to weighting class ℓ is found; denote this sum by $WN(\ell)$. The response k is then randomly imputed to nonrespondents in weighting class ℓ so that their sample weights sum to

$$WN(\ell k) = \rho(k\ \ell)\ WN(\ell) \quad .$$

The nonrespondents in class ℓ to which the response k is to be imputed is determined in the following manner. First, list the nonrespondents with their sample weights in random order. Go down the list, summing weights until the sum equals $WN(\ell k)$. Impute the response k to the corresponding sample members. Continue this procedure until all nonrespondents in weighting class ℓ have had a response imputed for the missing item. The estimated proportions making each response would then be determined in the usual way. Estimates of response level proportions will be the same as that which would have resulted had a weighting class adjustment procedure been used, except for weight accumulations that cannot be expected to break precisely at the place desired. To the extent that this categorical imputation technique produces the same estimated response proportions as a weighting class adjustment procedure, variance approximations for the weighting class adjustment procedure should be appropriate for the imputation-based procedure. This is different from the hot

deck procedure for which an analytical expression for the variance is not available.

D. The Creation of Weighting Classes for Use in Imputation

Before implementing a weighting class imputation procedure, the sample must be partitioned into classes. The hot deck and cold deck imputation procedures can also perform more efficiently if the sample is divided into classes before imputation occurs. In both instances, characteristics must be identified which define weighting classes which vary with respect to response rates and survey estimates. For this investigation, the weighting classes were based upon the student's race, sex, high school grades, high school curriculum, and parents' education. Although these weighting classes were initially created to adjust for total questionnaire nonresponse, it was felt that they would also be applicable in this investigation because of the large number and diversity of items studied. The analyst using only a few items from the NLS data file should construct special weighting classes before imputing for missing values. The remainder of this section discusses procedures that may be used to form weighting classes.

In constructing weighting classes, the overall goal is to form classes for which the responses within classes are homogeneous and heterogeneous between classes and for which the response rate varies. Further, the characteristics used to define the weighting classes must be known for both respondents and nonrespondents. The choice of survey characteristics to use should reflect the following ideas:

1. Usually more gain results from the use of the coarser division of several variables than from finer divisions of one.

2. There is no need for completeness or symmetry in forming cells. Smaller cells may be combined.

3. Different criteria may be used for different subgroups. It may be decided to partition males with respect to different characteristics than females.

4. The classifying variables should be unrelated to each other. If two variables are highly correlated, then either will describe approximately the same amount of variation.

To summarize then, the weighting classes that are formed should be as different as possible; this also corresponds to having classes internally as homogeneous as possible. Cluster analysis is particularly appropriate both for choosing the best set of classifying variables and for determining how each variable chosen should be used to subdivide the units into classes. A clustering technique that may prove effective in this regard is Automatic Interaction Detection (AID) Analysis (Hartigan, 1975). The AID algorithm operates by successively dichotomizing the sample according to the factor level (classifying variable) that minimizes the within weighting class sum of squares for the dependent variable. The result is a "tree" of clusters (weighting classes) having similar dependent variable values where the clusters are defined by the levels of the factors selected in the computing algorithm.

III. THE DESIGN OF THE EMPIRICAL INVESTIGATION

In considering the implementation of a nonresponse imputation procedure, one needs to be concerned about the quality of the resultant statistics. Since nonresponse imputation procedures are proposed to reduce the bias that may result from the different characteristics of respondents and nonrespondents, the amount of bias in the estimates when one of these procedures is used is crucial. This cannot be determined in any useful analytic fashion because the bias will depend on whether the assumptions underlying the adjustment technique hold. For instance, all of the techniques discussed in the previous section assume that the respondent and nonrespondents within each weighting class have responses that are similarly distributed. The extent to which respondents and nonrespondents differ will influence the degree to which the resulting estimators are biased. Other factors of importance are the degree to which responses within weighting classes are homogeneous and the extent to which response rates differ between weighting classes.

At the present time no item nonresponse imputation procedure is being used for NLS data. This empirical investigation studied two nonresponse imputation techniques that appeared to be suited for NLS data. In this investigation, a weighting class imputation procedure and a hot deck imputation procedure were compared with respect to bias, variance, and mean square error to the no item nonresponse imputation approach. The bias and mean square error were determined based upon the results using a data set in which missing responses were secured by follow-up efforts. The following sections discuss the construction of the experimental data set for this investigation and the utilization of this data set.

A. Construction of the Experimental Data Set

To assess the bias associated with each of these nonresponse adjustment procedures, a data set was needed in which item nonresponse occurred for some of the sample members and where the missing item responses could then be analysed using first the weighting class imputation technique, second the hot deck imputation technique, and finally the no imputation technique. These results could then be compared to that obtained when the missing responses are added to the data set via telephone follow-up.

Rather than constructing a data set with artificially induced nonresponse, the decision was made to use actual data that contained item nonresponse for which the answers were subsequently obtained by telephone follow-up activities. By using data with naturally occurring patterns of item nonresponse, it was felt that a better understanding could be obtained of the actual problems associated with item nonresponse and the effect of nonresponse adjustments on the precision of the resulting estimators. Such a data set was constructed from the NLS Third Follow-up (TFU) Survey by taking account of the following set of special circumstances. Certain items on the questionnaire were designated critical items by NLS staff. When an incoming questionnaire had a missing response or an inconsistent set of responses for one or more of these critical items, the questionnaire was marked as having failed edit. Subsequently, the individual involved was telephoned and the missing response(s) were added by the telephone operator. The data records for individuals whose questionnaires failed edit contained the responses to these critical items, but the records did not indicate what the original responses were or which responses were obtained by telephone editing.

In order to obtain this information on the responses before telephone resolution, the questionnaires were re-examined by data editors and the original responses to the selected critical items were recorded. In all, a total of 10,850 questionnaires failed edit. For reasons of economy, a subsample of size 5,854 was selected for re-examination. The following 20 items were chosen to be representative of the types of items on the NLS instrument. These were examined on each of the selected questionnaires: TQ1, TQ9, TQ10, TQ12, TQ15, TQ16, TQ29, TQ33, TQ51, TQ52, TQ66, TQ89, TQ90, TQ101, TQ102, TQ118, TQ129, TQ131, TQ136, and TQ141.

Except for TQ15, TQ16, TQ89, and TQ141, the selected items have categorical responses with TQ1, TQ9, TQ131, and TQ136, allowing the student to choose multiple response options. Item TQ10 was the lead-in question to a routing pattern with TQ12 to be answered by the unemployed and TQ15, TQ16, and TQ29 to be answered by the employed. Another major routing pattern was controlled by TQ51, which directed those not attending school in 1974-1976 to skip to item TQ98. Other items found within routing patterns were TQ33, which had as its lead-in item TQ32, TQ102 with lead-in item TQ101, and TQ131 and TQ136 with lead-in item TQ129. Finally, the four continuous items, TQ15, TQ16, TQ89, and TQ141, requested hours worked, weekly salary, college ex-

penses, and annual income. These questions were more sensitive and, historically, these types of questions exhibit higher rates of item nonresponse. The text of all of the selected items may be found in Appendix C.

The subsample of TFU questionnaires that failed edit was examined. A working file was constructed containing the student identification code and additional codes to indicate whether or not each of the 20 items failed edit and, if so, what the original answer was. The coding used by the data editors is presented in Appendix B. The working file was then merged with the NLS Third Follow-Up File to create the two data files that were used in this investigation. The first file (hereafter referred to as the data file of telephone corrected and completed information) which was abstracted from the NLS Third Follow-Up File, contains the data records for those students who passed edit, combined with the subsample of those who failed edit. This file contains responses to the items after telephoning was used to replace missing responses and correct inconsistent responses. The second file, referred to as the pre-telephoning file, contains the responses to the 20 questions before telephoning was used to correct the data set. Since only a sample of the fail-edit mail questionnaires were included in the investigation, the sampling weights on the data records corresponding to these individuals were adjusted so that the sum of the weights of the subsampled mail questionnaires that failed edit for each weighting class equaled the sum of the weights of all the mail questionnaires that failed edit from that weighting class. No weight adjustments were needed for the data records corresponding to those questionnaires which passed edit or those completed by personal interview since all of these questionnaires were included in the study.

B. Response Error Rates in the Experimental Data Set

For each of the selected 20 items, the status of the response before telephone follow-up was determined. A summary of the status of the original responses to these items for the sample of fail edit questionnaires is given in Attachment B-2 of Appendix B. These results were based upon the subsample of size 5,854 drawn from the 10,850 questionnaires that failed edit. Adding in the 9,235 questionnaires which passed edit (and hence had complete, consistent responses to the critical items) and adjusting to account for the sampling of fail-edit questionnaires yields the estimated response error rates

for the full NLS sample presented in Table 3-1. Since the experimental data set had the sampling weights of fail-edit questionnaires adjusted to account for the subsampling, these error rates also apply to the experimental data set. Except for 2 multiple response option questions (TQ1 and TQ9) and 4 financial questions (TQ89HA, TQ89HB, TQ141FA, and TQ141FB), 95 percent of the questionnaires contained a response for an item that was consistent with other responses on the questionnaire. The highest rates of missing or blank responses were found for the income items, TQ141FA and TQ141FB, with about 13 percent nonresponse. Items TQ1 and TQ9 had the highest inconsistency rates; that is, the responses to TQ1 and TQ9 were most frequently in conflict with other questionnaire items. The "other" category in Table 3-1 is composed of those who failed an item but could not be contacted for telephone resolution.

From examining Table 3-1, one can verify that the data set that could be constructed of the original responses for the full NLS sample to the 20 critical items would have a relatively small rate of item nonresponse and a somewhat larger rate of inconsistent responses. Since the experimental data set contained only a half of the fail-edit questionnaires with weight adjustments to account for the subsampling, these rates also apply (with respect to their effect on survey estimates) to the experimental data set as well. However, in the physical process of imputing data, the actual number of nonrespondents to each of the 20 items becomes important. This information is presented in Table 3-2. When one considers that the experimental data set contains 15,089 records, the number of nonrespondents is quite obviously of little practical importance except for the income items, TQ141FA and TQ141FB.

C. The Utilization of the Experimental Data Set

The data set of original responses whose construction was discussed in previous sections was used to evaluate the hot deck and weighting class imputation procedures with respect to the no imputation procedure. In order to understand the results of the investigation, details are needed as to how the techniques were implemented. This section will discuss the logical editing used before imputation of missing values, the hot deck and weighting class procedures as implemented in this investigation, and the estimation of the bias, variance, and mean square error of the estimates.

Table 3-1.--Classification of original responses to the twenty selected critical items

Item	Original response			
	Consistent	Blank	Inconsistent	Other
Discrete				
TQ1	92.4	0.2	6.7	0.7
TQ9	87.1	0.3	11.7	1.0
TQ10	96.0	0.9	2.7	0.4
TQ12	97.3	0.5	2.0	0.3
TQ29	99.0	0.5	0.3	0.2
TQ33	95.1	0.5	4.0	0.4
TQ51	97.5	0.9	1.2	0.4
TQ52	96.1	0.9	2.6	0.4
TQ66	94.5	1.1	4.0	0.5
TQ90	97.3	1.4	0.9	0.4
TQ101	98.5	1.0	0.2	0.3
TQ102	99.1	0.2	0.5	0.2
TQ118	97.1	2.4	0.1	0.4
TQ129	97.2	0.5	0.1	0.1
TQ131	99.5	0.2	0.2	0.1
TQ136	99.6	0.2	0.1	0.1
Continuous				
TQ15	98.6	0.6	0.5	0.3
TQ16	97.3	1.8	0.6	0.4
TQ89HA	92.9	2.6	3.8	0.7
TQ89HB	92.5	2.8	4.0	0.8
TQ141FA	82.9	12.9	2.4	1.9
TQ141FB	82.5	12.9	2.7	1.9

Table 3-2.--The number of missing responses for each item in the experimental data set

Item	Number of missing responses
TQ1	16
TQ9	32
TQ10	96
TQ12	51
TQ15	66
TQ16	192
TQ29	59
TQ33	54
TQ51	98
TQ52	95
TQ66	114
TQ89HA	286
TQ89HB	303
TQ90	150
TQ101	104
TQ102	25
TQ118	258
TQ129	57
TQ131	23
TQ136	22
TQ141FA	974
TQ141FB	1030

1. Logical Editing Before Imputation of Missing Values

At the start of this investigation, a decision had to be made concerning the procedures to deal with inconsistencies. As the previous section demonstrated, inconsistent data occurred more often than missing data and for some items was a much more serious source of error. Judging from where the inconsistencies occurred, the major problem other than with TQ1 and TQ9 appeared to be associated with the routing pattern questions. Thus in reconstructing the data set, the decision was made to leave inconsistent data as observed rather than to code inconsistent items as blank.

In computing the no imputation estimates, no attempt was made to force consistency on the data within records. However, the hot deck imputation program and the weighting class imputation program included provisions to force consistency on data associated with routing patterns by requiring that the responses within a routing pattern agree with the lead-in question to the routing pattern. When the responses within a routing pattern disagreed with the lead-in question, all of the responses within the routing pattern were coded as missing except for items which should have been skipped. These were coded as legitimate skips. For example, a common error was for an individual to respond "4" to TQ10 (indicating that he was not employed the first week of October 1976) then to respond to TQ12 (indicating whether or not he was looking for work), and then, instead of skipping TQ15, TQ16, and TQ29 as instructed, to respond to these items, often giving nonsensical answers to these items which requested hours worked per week, weekly salary, and whether the individual was seeking a second job. In this case, TQ15, TQ16, and TQ29 would be recoded to legitimate skips and the response to TQ12 would be recoded to missing (since this response is also in doubt).

2. Implementation of the Hot Deck Imputation Procedure

The hot deck procedure was relatively easy to program and inexpensive to run with respect to computer time. Before using the hot deck imputation procedure, the data file was sorted into 87 weighting classes and then according to sample design strata and school within strata. The weighting classes which were based upon the student's race, sex, high school grades, high school curriculum, and parents' education were originally formed for total questionnaire nonresponse adjustments. These weighting clases were adapted for item nonresponse imputation by incorporating certain routing

pattern lead-in questions. In general, an initial hot deck was formed for each weighting class by going through the data file and recording the first completed response to each item. As the new data was processed, the weighting class to which each individual belonged was determined. If the item being examined was complete, that individual's response replaced the response stored in the hot deck for that weighting class. Thus, new responses were supplied for the hot deck as they appeared in the data file. When a questionnaire was encountered with a missing item, the response in the hot deck for that weighting class was imputed for the missing response.

To adapt this procedure for items contained within routing patterns, the following rules were applied. For all items within a routing pattern, the weighting class or cell to which an individual belonged was based upon the NLS weighting class and on his response to the lead-in item. If he responded in a consistent fashion to the lead-in item and the items within the routing pattern, then his responses to these items were entered as a group into the hot deck. Thus, in imputing for items within a routing pattern, either all of the items within the routing pattern were consistent and complete, in which case they entered the hot deck, or one or more of the items were missing or inconsistent, in which case the responses to the group of items within the routing pattern were replaced by responses stored in the hot deck for the same NLS weighting class and the same response to the lead-in question. When the response to the lead-in item was missing, responses for the lead-in item and all items within the routing pattern were imputed as a block from the hot deck for the same weighting class as that to which the individual belonged.

3. Implementation of the Weighting Class Imputation Procedure

The second item nonresponse imputation technique investigated was a procedure which we refer to as "weighting class" imputation. For quantitative variables, the weighting class imputation procedure simply replaced missing values by the estimated respondent mean for the weighting class containing the individual. When a mean or total is being estimated, this weighting class imputation technique results in the same estimate as that obtained when weight adjustments are made within weighting clases. For categorical items with missing responses, the weighting class imputation technique randomly assigned responses in such a manner that within each weighting class the weighted proportion of nonrespondents assigned each response option was equal (as far as possible) to the proportion of respondents who gave that response. Esti-

mates of response option proportions will be only approximately the same as those which would have resulted had a weighting class adjustment procedure been used, since the weight accumulations will not break at precisely the point desired. To adapt this procedure for items within routing patterns, the weighting class an individual belonged to was determined by the NLS weighting class to which he was assigned and by his response to the lead-in question to the routing pattern. If the lead-in item was not answered as well, a response was first imputed for the lead-in question and then responses were imputed for the items within the routing pattern.

As an example of the use of the weighting class imputation procedure, suppose that an individual from weighting class 14 failed to respond to TQ10, the lead-in item, and to TQ12, TQ15, TQ16, and TQ29, items within the routing pattern controlled by TQ10. The text of these questions is given in Appendix C. Essentially, TQ10 asked an individual's employment status with TQ12 to be answered by those unemployed and TQ15, TQ16, and TQ29 to be answered by those employed. In order to insure consistency of the responses to routing pattern questions, the lead-in question was imputed first if the response was missing. Since TQ10 is a categorical item, the randomization procedure described previously would be used to determine which one of the four responses to impute. For TQ10, the weighting classes used were the original NLS weighting classes used to adjust for instrument nonresponse. In this hypothetical case the individual belongs to NLS weighting class 14, so the imputation procedure would proceed as discussed previously for all individuals from this weighting class with missing responses. Suppose that the response "2" was imputed for TQ10 for this individual indicating that he was employed part-time; as a result, TQ12 would be automatically coded as a legitimate skip since this item was to be answered only by those unemployed. Since TQ15 and TQ16, which request hours worked per week and weekly salary, have continuous responses, the estimated respondent means for TQ15 and TQ16 (computed for the set of individuals from weighting class 14 who responded "2" to TQ10) would be imputed for the missing responses to TQ15 and TQ16. Now since TQ29 is within the routing pattern controlled by TQ10, the proportions responding "1" and "2" to TQ29 would be estimated, based upon the respondents from weighting class 14 who responded "2" to TQ10. Then response options "1" and "2" would be randomly assigned to all the nonrespondents to TQ29 from

weighting class 14 who responded "2" to TQ10 in such a manner that the weighted proportion of nonrespondents assigned each of the 2 responses will equal, as far as possible, the correponding weighted proportions from TQ29 respondents in weighting class 14 who responded "2" to TQ10.

D. Estimation of the Bias Associated With Survey Estimates

By using actual data that contained item nonresponse for which the answers were subsequently obtained by telephone follow-up, the bias could easily be estimated for the two imputation procedures and the no imputation method as the difference between the estimates obtained using the imputation (or no imputation) procedure on the pre-telephone data set and the estimates obtained using the data set which had been corrected by telephone interviewing. Since the pre-telephone data set contained inconsistent responses as well as missing responses, the bias that was obtained reflected these two response error sources and, hence, contained nonresponse bias and measurement error bias due to inconsistent data. As will be discussed later, it was possible to partition out this response error bias caused by inconsistent answers. The magnitude of this response bias establishes an upper limit on the effectiveness of the imputation procedures since they were designed primarily to reduce the nonresponse or missing data component of the overall bias.

E. Estimation of the Variance Associated With Survey Estimates

The variance of the sample means and proportions was estimated using a variation of the balanced repeated replication (BRR) technique proposed by McCarthy (1966) for estimating the variance of complex survey statistics. BRR utilizes a balanced set of half samples to compute the sampling variance of these statistics where the variability of the replicated estimates approximates the variance of the full sample statistic. In this investigation, the item nonresponse imputation procedures were separately applied to the balanced half samples to obtain BRR variance estimates which reflect the variability induced by the imputation procedures.

As mentioned previously, most users of imputation procedures ignore the fact that imputation has occurred when computing the variance of survey estimates. The reason for this is that computing accurate variance approximations which allow for the fact that imputation occurred is both difficult

and costly. While we feel that pseudoreplication methods should provide valid estimates of the variance induced by imputation, the standard software packages for these procedures do not allow one to employ the imputation procedure on each individual half sample before computing the half sample estimates. As discussed in Appendix D, the imputation procedure must be applied independently to the half samples in order to estimate the variance induced by the imputation procedure. Thus some software development would be necessary to create one's own or to modify existing packages before the variance of imputation-based statistics could be estimated. Among the objectives of this investigation was the determination of the effect of imputation on the variance of survey estimates and the underestimation effect caused by ignoring imputation in computing variance estimates. A discussion of the theory underlying the balanced repeated replication procedure is given in Appendix D as well as a justification for using the procedure in the manner specified to compute the variance of imputation-based statistics.

To estimate the variance when imputation was ignored, STDERR, an RTI software package, was used. This package utilizes a Taylor Series linearization to estimate the variance of complex survey estimates (see Appendix E for the specific variance estimation formulas). For the ratio estimates of means and proportions used exclusively in this investigation, the Taylor Series expansion of the variance results in the usual estimate for the variance of a ratio estimate as given in standard sampling texts (e.g., Cochran, 1977, pp. 153-154). As a side issue of this investigation, the STDERR and BRR variance estimates were computed for the survey estimates obtained when no imputation was used. In this situation, the two procedures were measuring the same quantity so that the two variance estimates could be compared.

F. Estimation of the Mean Square Error Associated with Survey Estimates

As discussed in Section III-D, the bias induced by item nonresponse and inconsistencies was defined to be the expected value of the difference between the imputation-based (or no imputation) estimate ($\hat{\mu}$) and the corresponding estimate ($\hat{\mu}_T$) obtained when the telephone corrected and consistent follow-up data are used. The magnitude of this bias was estimated by

$$\text{BIAS}\ (\hat{\mu}) = \hat{\mu} - \hat{\mu}_T \quad .$$

The mean square error (MSE) of the statistic $(\hat{\mu})$ was defined to be the expected value of the squared difference of the estimate from the value obtained using the post-telephone data which was estimated as

$$MSE\ (\hat{\mu}) = [Bias(\hat{\mu})]^2 + Var(\hat{\mu}) \quad .$$

Note that this estimate will be biased to the extent that the correlation between $\hat{\mu}$ and $\hat{\mu}_T$ is different from unity. The reason for this is that

$$E[Bias(\hat{\mu})]^2 = [Bias(\hat{\mu})]^2 + Var(\hat{\mu}) + Var(\hat{\mu}_t) - 2\,Cov(\hat{\mu},\hat{\mu}_T) \quad .$$

Since $\hat{\mu}$ and $\hat{\mu}_T$ are estimated from largely the same data set (except for moderate nonresponse), one would expect their correlation to be close to unity. With this anticipated high correlation, the joint contribution of the extra terms

$$Var(\hat{\mu}) + Var(\hat{\mu}_T) - 2\,Cov(\hat{\mu},\hat{\mu}_T)$$

should be negligible.

IV. RESULTS OF THE EMPIRICAL INVESTIGATION

The question of the magnitude of response errors and their effect on the quality of survey estimates is of great importance to users of the NLS survey data. Except for about 60 critical items on the survey instruments (approximately 1/3 of the total items), the data are not edited to replace missing data or resolve inconsistencies. As with the use of any survey instrument which requests the same or similar information in more than one item, inconsistencies between the responses to similar items occur and indicate the presence of measurement error. The effect of this source of response error on the quality of survey estimates is of concern, as well as the effect of missing responses. Some questions that should be of concern to the researcher are the following:

1. What is the magnitude of the bias resulting from these sources of response error?
2. Is editing or deletion needed to reduce measurement error caused by inconsistent responses?
3. How serious is the error caused by nonresponse?
4. If a nonresponse bias imputation procedure is needed, which one would be "best" for the type of items being examined?

In this study, these questions were investigated for 20 critical items that were selected as representative of the various types of items found on the NLS instrument. After conversations with RTI's data editing staff, those key items that the data editors felt had the most missing or inconsistent data were selected. While the items studied in this investigation are similar in format to other items on the instrument, the frequency of response errors may be greater among the study items since the anticipated worst cases were selected. The original responses before telephone editing were used to form the data base for the investigation, and the responses after telephone resolution were used to judge the quality of the data set and the performance of the imputation procedures. The effect of response errors in the original data and the efficacy of the two common nonresponse adjustment procedures--hot deck and weighting class--are discussed in the remainder of this section.

A. Response Error Bias in the Experimental Data Set

Estimates of population values from sample surveys are subject to two kinds of error. Variable error is the random portion which includes sampling error attributable to the random selection of individuals rather than a complete census of all individuals, and also variable measurement errors due to the natural fluctuations in questionnaire responses and data transcriptions. The second type of error is bias which is a systematic error that can result from the estimation procedure, nonresponse, or nonsampling errors inherent in the measurement process. One may model the total error associated with using the sample estimate $\hat{\theta}$ to predict the population parameter θ by

$$\hat{\theta} - \theta = [\hat{\theta} - E(\hat{\theta})] + [E(\hat{\theta}) - \theta]$$

where $E(\hat{\theta})$ is the expected value of the statistic $\hat{\theta}$ over a conceptual sequence of repeated samplings and repeated interviewing-transcribing trials for a given sample. The first term represents the variable errors; the second term represents the bias. The mean square error (MSE) is defined as the expectation of the squared total error and is given by

$$E[\hat{\theta} - \theta]^2 = E[\hat{\theta} - E(\hat{\theta})]^2 + [E(\hat{\theta}) - \theta]^2$$

$$MSE = Var(\hat{\theta}) + [Bias]^2$$

The first term of the MSE is the sampling variance of the estimate $\hat{\theta}$; the second term is the square of the bias of the estimate.

The ultimate problem of the sample designer is to construct a sample survey in such a way that the total error of the results is minimized (not just the random sampling error). This means that concern must be given to the protocol for collecting the data, the design of the survey instrument, and the number of individuals to be surveyed. Similarly, in utilizing the survey data, the investigator must also be concerned with the total error. After the data is collected, however, the variable or sampling portion of the error is fixed. In this case, the investigator should be concerned with the extent of instrument and item nonresponse, and with the amount of systematic measurement or response error that is evident in the data. Various imputation procedures

are available to reduce the bias caused by nonresponse, and logical editing and/or deletion may be used to resolve inconsistencies which are symptomatic of response or measurement errors in the data.

The effect of bias when drawing inferences from survey data can be illustrated by examining the effect on interval estimates and their associated confidence coefficients. When bias is present, the entire sampling distribution of $\hat{\theta}$ about θ is displayed by an amount equal to the bias. This results in a distortion of the areas in the tails of the sampling distribution of the appropriate test statistic. For example, suppose $(\hat{\theta} - \text{Bias} - \theta)/S_{\hat{\theta}}$ is distributed as Student's t, in which case the proper two-tailed confidence limits for θ with confidence coefficient α are given by

$$\hat{\theta} + t\, S_{\hat{\theta}} \left[\pm 1 - \frac{\text{Bias}}{t S_{\hat{\theta}}} \right]$$

where t is the value of the t statistic at $1 - \alpha/2$. If the bias is positive, the standard interval represented by the confidence limits

$$\hat{\theta} \pm t\, S_{\hat{\theta}}$$

will exceed θ more frequently than it should. Negative bias will have the opposite effect. For each increase of 0.5 in the absolute bias ratio, $(\text{Bias}/S_{\hat{\theta}})$, the probability that the corresponding interval fails to contain θ will be approximately doubled. If, for example, the bias ratio for a sample statistic is 1.0, a presumed 95 percent confidence interval would have a chance of about 20 percent of excluding θ instead of a 5 percent chance.

In most surveys, the bias of sample estimates is not known. However, in this empirical investigation, the bias in survey estimates due to using data containing item nonresponse and items whose responses are logically inconsistent with one another could be determined since telephone corrected and completed data were also available. As discussed in Section 3.2, the experimental data set that was constructed of the original responses to the 20 selected critical items had a relatively low rate of item nonresponse and a somewhat larger rate of inconsistencies. The rate of inconsistencies for an item is somewhat misleading since it is a measure of the proportion of times a

response given to that particular item disagrees with other responses on the same instrument. An inconsistent response may be correct or incorrect. However, if the responses to two different items logically disagree, then at least one of the items is incorrectly answered. This obvious source of measurement error was investigated as well as nonrespondent bias. To the extent that the 20 critical items are representative of the NLS instrument, comments concerning response and nonresponse errors in estimates and procedures to deal with these errors apply to other items on the instrument as well.

In general, considering the fact that the critical items selected were judged most prone to response and nonresponse errors, the quality of the data appears to be relatively good, even before the telephone editing. Three measures of quality--the relative bias, the relative root mean square error, and the bias ratio of an estimate--were used to evaluate the accuracy of the estimates resulting from the 20 selected critical items.

The relative bias (RB) is defined to be the bias divided by the population value being estimated. This measure of data quality reflects the common specification of data analysts that greater accuracy is needed for estimates of smaller population values. For this study, the relative bias of a statistic was estimated as the bias (the difference between the statistic and $\bar{Y}$-TRUE), divided by the "true" population value ($\bar{Y}$-TRUE) obtained using the telephone edited and corrected data. Of the 51 estimates computed for the entire population using the experimental data set of 14 discrete items with no imputation or editing procedure (NI),. 42 have moderate to low relative biases of less than 5 percent (see Table 4-1). The average relative bias for the 51 discrete estimates was 2.25 percent. The estimates of the mean value for the entire population for the 6 continuous questions had an average relative bias of 0.8 percent, and all estimates have relative biases of less than 5 percent (see Table 4-2).

The relative root mean square error ($R\sqrt{MSE}$), which was defined to be the square root of the mean square error of the statistic being estimated divided by the value of the estimate obtained when the telephone edited and corrected data were used ($\bar{Y}$-TRUE), is a better measure of the quality of the data base. However, these estimates obtained using the experimental data set do not reflect the quality of the NLS data set, since the experimental data set was only about three-fourths the size of the full data set. This occurred due to the fact that only one-half of the fail-edit mail questionnaires were included

Table 4-1.--Comparison of no imputation estimates when inconsistent data is removed (NIC) and when retained (NI) - Part 1: Proportions estimated for the total population

ITEM	RESPONSE	SAMPLE SIZE	Y-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
T01A	1	15089	72.29	-1.74	-2.40	-2.38	0.96	-4.21	1.52	2.45	1.14
T01C	1	15089	17.16	-0.07	-0.40	-0.31	-8.97	-0.14	-4.40	2.21	9.19
T01D	1	15089	4.12	0.30	7.28	7.06	-8.37	1.67	-1.70	8.23	9.70
T01G	1	15089	9.19	-1.25	-13.59	-13.67	-13.37	-5.06	-4.90	13.93	13.64
T09A	1	15089	67.82	-4.49	-6.62	-6.69	-0.98	-9.05	-1.13	6.73	1.30
T09C	1	15089	32.15	-0.56	-1.74	-1.63	-9.72	-1.03	-6.81	2.27	9.83
T09D	1	15089	3.96	0.01	0.25	0.53	-18.47	0.11	-4.43	4.67	18.93
T09G	1	15089	7.00	-1.57	-22.41	-22.54	-22.84	-5.21	-4.67	22.96	23.36
T010	1	15089	61.22	0.06	0.09	0.09	1.99	0.10	2.28	0.87	2.18
T010	2	15089	13.06	-0.05	-0.38	-0.24	-9.53	-0.09	-3.83	2.66	9.85
T010	3	15089	1.45	-0.06	-4.13	-5.97	-14.93	-0.77	-1.82	9.76	17.02
T010	4	15089	24.27	0.05	0.20	0.26	0.98	0.16	0.64	1.62	1.81
T012	1	3644	25.66	1.38	5.37	5.03	-12.77	1.41	-3.38	6.16	13.32
T012	2	3644	7.20	-0.01	-0.13	0.52	5.38	0.07	0.72	7.05	9.17
T012	3	3644	67.14	-1.37	-2.04	-1.98	4.30	-1.18	2.39	2.59	4.66
T029	1	11439	91.40	0.01	0.01	-0.03	0.06	0.09	0.15	0.39	0.40
T029	2	11439	8.60	-0.01	-0.11	-0.39	-0.64	-0.09	-0.15	4.22	4.32
T033	1	4234	17.56	1.26	7.17	6.79	-22.97	1.51	-4.52	8.14	23.53
T033	2	4234	3.57	0.31	8.68	9.81	5.95	1.33	0.70	12.26	10.33
T033	3	4234	78.87	-1.57	-1.99	-1.95	4.84	-1.90	3.71	2.20	5.01
T051	1	15089	47.13	0.42	0.89	0.48	-0.23	0.36	-0.18	1.40	1.31
T051	2	15089	52.87	-0.42	-0.79	-0.43	0.21	-0.36	0.18	1.25	1.17
T052	1	7579	49.75	0.24	0.48	0.61	-0.18	0.45	-0.12	1.47	1.47
T052	2	7579	50.25	-0.24	-0.47	-0.60	0.18	-0.45	0.12	1.46	1.46
T066	1	7579	20.29	0.29	1.42	1.32	-1.17	0.77	-0.59	2.16	2.29
T066	2	7579	32.03	1.08	3.37	4.15	3.73	2.52	2.15	4.52	4.11
T066	3	7579	47.68	-1.38	-2.89	-3.35	-2.00	-2.26	-1.50	3.66	2.40
T090	1	7579	65.64	0.12	0.18	0.19	0.81	0.16	0.73	1.16	1.38
T090	2	7579	4.67	0.26	5.57	5.73	-0.64	0.77	-0.09	9.33	6.58
T090	3	7579	5.79	0.02	0.34	0.93	-1.15	0.14	-0.18	6.59	6.36
T090	4	7579	23.90	-0.40	-1.67	-1.87	-1.84	-0.52	-0.52	4.03	3.99
T0101	1	15089	84.17	-0.01	-0.01	-0.12	-0.15	-0.30	-0.38	0.42	0.43
T0101	2	15089	15.83	0.01	0.06	0.66	0.82	0.30	0.38	2.26	2.30
T0102	1	2199	66.64	-0.53	-0.79	-0.46	0.34	-0.23	0.16	2.04	2.08
T0102	2	2199	33.36	0.53	1.58	0.92	-0.69	0.23	-0.16	4.09	4.15
T0118	1	15089	92.68	0.00	0.00	-0.09	-0.05	-0.42	-0.21	0.25	0.24
T0118	2	15089	0.90	0.01	1.11	1.98	-2.23	0.19	-0.20	10.33	11.01
T0118	3	15089	6.42	-0.01	-0.15	1.16	1.04	0.29	0.26	4.06	4.00
T0129	1	15089	9.78	0.02	0.20	-0.17	-0.55	-0.04	-0.14	3.92	3.97
T0129	2	15089	45.95	0.00	0.00	-0.06	-0.02	-0.07	-0.02	0.91	0.91
T0129	3	15089	4.02	-0.01	-0.24	0.07	0.02	0.01	0.00	5.08	5.07
T0129	4	15089	40.25	-0.01	-0.02	0.10	0.16	0.15	0.22	0.70	0.73
T0131A	1	6336	73.00	0.11	0.15	0.07	0.03	0.08	0.03	0.91	0.93
T0131C	1	6336	7.87	-0.02	-0.25	-0.03	0.19	0.00	0.03	6.38	6.44
T0131D	1	6336	4.30	0.00	0.08	0.08	0.32	0.00	0.02	11.53	11.54
T0131F	1	6336	26.45	-0.02	-0.07	0.16	0.26	0.04	0.07	3.38	3.41
T0136BOX	1	7010	18.19	0.02	0.10	0.00	0.06	0.00	0.01	3.45	3.45
T0136A	1	5743	71.91	0.00	0.00	0.00	-0.01	0.00	-0.01	1.06	1.06
T0136C	1	5743	9.09	0.00	0.00	0.37	0.39	0.06	0.06	5.71	5.72
T0136D	1	5743	3.89	0.00	0.00	-0.19	-0.16	-0.02	-0.02	7.76	7.76
T0136F	1	5743	21.81	0.01	0.04	-0.39	-0.43	-0.11	-0.12	3.52	3.51

Table 4-1. (continued)--Comparison of no imputation estimates when inconsistent data is removed (NIC) and when retained (NI) - Part 2: Means estimated for the total population

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI $R\sqrt{MSE}$%	NIC $R\sqrt{MSE}$%
IQ15	11445	38.75	0.00	0.00	0.04	0.14	0.12	0.43	0.33	0.37
IQ16	11445	160.26	-0.21	-0.13	0.14	0.27	0.22	0.44	0.63	0.68
IQ89HA	7579	2102.30	7.68	0.36	1.20	0.60	0.87	0.45	1.81	1.45
IQ89HB	7579	2173.09	40.05	1.84	2.38	0.58	1.50	0.44	2.86	1.41
IQ141FA	15089	7039.68	-17.34	-0.24	-0.44	-0.30	-0.44	-0.29	1.08	1.06
IQ141FB	15089	6704.41	-38.25	-0.43	-0.57	-0.41	-0.66	-0.53	1.04	0.89

Glossary of Terms Used in Table

SAMPLE SIZE - number of sample members eligible to respond to a particular item for the domain under consideration.

$\bar{Y}$-TRUE - the estimate obtained using the telephone corrected and completed data.

ME - measurement error caused by the use of data containing logical inconsistencies.

RB% - the relative bias defined to be the bias divided by the value of $\bar{Y}$-TRUE, expressed as a percentage.

BR - the bias ratio defined as the bias divided by the standard error of the estimate.

$R\sqrt{MSE}$% - the relative root mean square error defined as the square root of the mean square error divided by the value of $\bar{Y}$-TRUE and expressed as a percentage.

Table 4-2.--Average quality of the data for selected subdomains

Domain		Discrete Items				Continuous Items			
		Average ME $\lvert RBZ \rvert$	Average NI $\lvert RBZ \rvert$	Average NI $\lvert BR \rvert$	Average NI $R\sqrt{MSEZ}$	Average ME $\lvert RBZ \rvert$	Average NI $\lvert RBZ \rvert$	Average NI $\lvert BR \rvert$	Average NI $R\sqrt{MSEZ}$
Total		2.11	2.25	0.91	4.64	0.50	0.80	0.64	1.29
Sex:	Male	1.98	2.08	0.65	5.90	0.72	1.01	0.50	1.87
	Female	2.62	2.78	0.64	6.96	0.29	0.43	0.26	1.59
Ability:	Low	2.63	2.98	0.43	8.83	0.69	1.42	0.37	3.26
	Middle	2.72	2.83	0.64	7.07	0.86	0.79	0.35	1.97
	High	2.31	2.71	0.59	8.62	0.55	0.61	0.32	1.80
SES:	Low	2.41	2.50	0.49	7.02	0.78	1.41	0.54	2.50
	Middle	2.51	2.74	0.66	6.20	0.32	0.58	0.38	1.38
	High	2.49	2.73	0.65	8.18	0.72	0.78	0.37	1.97
Race:	Black	3.41	3.74	0.49	10.25	1.16	2.01	0.62	4.02
	White	2.00	2.16	0.74	5.23	0.47	0.72	0.55	1.30
	Hispanic	4.97	3.03	0.35	12.10	0.29	9.36	0.48	17.28
	Other	2.74	3.03	0.35	12.10	1.04	1.19	0.28	3.51
Region:	Northeast	2.64	2.86	0.51	9.19	0.88	1.28	0.49	2.54
	South	2.16	2.43	0.69	7.11	0.38	0.38	0.26	1.50
	North Central	2.39	2.74	0.59	6.23	1.12	1.50	0.66	2.60
	West	2.32	2.53	0.51	8.09	0.35	0.51	0.23	2.30
Race x Ability:									
Black:	Low	4.35	4.96	0.42	14.76	1.75	4.72	0.67	8.15
	Middle	3.15	3.69	0.35	21.99	0.53	1.27	0.22	6.45
White:	Low	2.42	2.73	0.26	12.13	0.79	0.69	0.21	3.71
	Middle	2.86	3.00	0.58	7.82	0.82	0.72	0.31	2.01
	High	2.31	2.77	0.57	8.64	0.57	0.63	0.33	1.79
Other:	Low	4.58	5.06	0.25	22.76	1.46	2.85	0.33	7.98
	Middle	3.24	3.68	0.20	22.12	2.67	2.86	0.28	7.25
	High	3.22	3.54	0.22	31.08	0.59	1.21	0.20	7.08

NOTE.--The domain estimates for blacks of high ability and cross tabulations involving Hispanics were not included in this table since there were too few in the sample to compute valid variance estimates. For the rest of the domains, the average of the absolute value of the relative biases expressed as a percentage ($\lvert RB\% \rvert$), is given for the measurement error due to inconsistencies in the data (ME) and for the total error of the no imputation (NI) esitmates. For the no imputation estimates, the age of the absolute values of the bias ratios ($\lvert BR \rvert$) and the average he relative root mean square errors ($R\sqrt{MSE}$) are also given for each domain.

in the data set. The weights were adjusted as discussed in Section III-A to account for the subsampling so that the means and proportions are valid estimates; however, the variance of the estimates will be larger than what would be obtained had the full data set been used. Thus the relative root mean square errors of the estimates will also be larger than if the full data set had been used. For the estimates of proportions using the entire population as the domain, 34 of the 51 estimates had relative root mean square errors of less than 5 percent and 46 were less than 10 percent. The average relative root mean square error for the 51 proportions estimated from the 14 discrete items was 4.64 percent. All of the estimated means for the entire population resulting from the 6 continuous items had relative root mean square errors that were less than 5 percent, with an average value of 1.29 percent (see Table 4.2).

A final measure of the quality of the survey estimates is the bias ratio (BR). The bias ratio was defined to be the bias of an estimate divided by the standard deviation of the estimate. The bias ratios presented in this paper are, again, not the same as those which would have resulted had the full data set been used. In this case, the bias ratios should be smaller than those for the full data set since the denominator or standard deviation is larger due to subsampling increasing the variance of the estimates. As mentioned previously, the error rates for confidence intervals double for every increase of 0.5 in the absolute value of the bias ratio. Considering that the bias ratios obtained using the experimental data set would be expected to be less than those using the full data set, the quality of the estimates with respect to the bias ratios is not as good. Because the large sample size results in small variances, even a moderate bias can have a large effect. Looking at total population estimates, 17 of the 51 estimated proportions and 3 of the 6 estimated means have absolute bias ratios greater than 0.5 with 13 proportions having bias ratios greater than 1.0. From examining Table 4.1, one can see that the large bias ratios are mainly associated with TQ1 and TQ9 and with items within routing patterns.

To determine the effect on the bias of inconsistencies which were occurring at a high rate, a data set was constructed that contained the original inconsistent data but had all nonresponse replaced by the response obtained in the telephone interview. The difference between the estimates obtained using this data and the estimates obtained using the data set with both inconsisten-

cies and nonresponse corrected is the bias due to the presence of inconsistent responses which will be referred to as the measurement error (ME) bias. Note that the estimates obtained from the experimental data set using no imputation or editing (NI) contain both this measurement error bias as well as nonresponse bias. Referring to Table 4.1, which gives both of these bias terms for the proportions estimated for the 14 discrete items, one can see that measurement error caused by inconsistent (and incorrect) responses was the most important component of the bias in the no imputation estimates. This is to be expected since the item nonresponse rate for discrete items was less than two percent in the experimental data set; hence, the associated nonresponse bias would be expected to be small as well.

A general conclusion that can be made for the discrete items is that nonresponse is not an important factor in the bias of the no imputation estimates and any imputation procedure that merely replaces missing values will not compensate for the most important source of bias, namely, measurement error due to inconsistent and incorrect responses. In fact, in many instances the nonresponse bias and the measurement error bias have opposite effects so that the total bias in the no imputation estimates is less than the measurement error bias. One easily implemented approach to the problem of inconsistent data might be to remove the inconsistent responses to various items and code the responses as missing. This procedure was used on the experimental data set and estimates were obtained using no imputation on this new data set which had only consistent responses but many more missing responses. Referring again to Table 4-1, which gives estimates for the discrete items for the entire population, one can see that, in general, the bias of the no imputation estimates when inconsistent data is removed (NIC, for no imputation, consistent data) is larger than the no imputation estimates obtained using the inconsistent data (NI). The problem is that a data item may be inconsistent with another data item and yet be correct, so that by discarding all responses to an item that are inconsistent with responses to other items on the same instrument, information is lost and nonresponse becomes a more serious problem. For instance, the discrete items TQ1 and TQ9 were multiple response option items in which the individual was questioned concerning his activities in October 1976 and October 1975 respectively (see Appendix C for the text of the questions). Although the individual was instructed to circle all options

which applied to him, a typical error was for an individual to circle only his principal activity. For instance, an individual working full time and taking one or two college courses at night often did not circle option number 3, "Taking academic courses at a two- or four-year college." Response errors such as these were often detected as an inconsistency when the individual responded "Yes" to TQ52 or TQ66, which asked if classes were taken during October 1976 and October 1975, respectively. Thus, inconsistent responses to TQ1 and TQ9 were often of the form where one option was circled when one or two additional options should have been circled as well. One can see, in this instance, that discarding all responses to TQ1 and TQ9 when an inconsistency is identified will not solve the problem. The discarded inconsistent data (which will now be regarded as missing) are atypical of the remaining data in that the proper edited responses for these excluded individuals are nearly always combinations of two or more of the possible activity states. Such deletions also exclude good response items which are inconsistent with other faulty items; for example, TQ52 may correctly indicate classes taken in 1976, while TQ1 fails to include the "Taking academic courses ..." option resulting in the deletion of good TQ52 data. Obviously, removing responses to items that are inconsistent with one another is not an adequate way of reducing the bias resulting from the use of data containing logical inconsistencies.

Another concern in evaluating the importance of response error biases is the effect on the bias of domain estimates. The following two sections will evaluate response error bias and total bias for the entire population and then for the selected domains of males, individuals of high ability, individuals with low socioeconomic status (SES), individuals from the South, and blacks of average ability. These particular domains were selected as being of special interest in illustrating the effects of differing response patterns and differing sample sizes. Tables presenting the results for these domains are given in Appendix F. Since removing inconsistent responses almost exclusively resulted in poorer estimates, only the response errors for the no imputation statistics computed using the experimental data set containing both inconsistent and missing data will be evaluated.

1. Response Errors in the Estimates for the Entire Population

The problems created by response error bias are entirely different for estimates obtained from discrete and continuous items, so these were

analyzed separately in this investigation. The differences can be seen by examining Attachment B-2 of Appendix B which gives the rate of nonresponse for each item and other response errors for the subsample of fail-edit questionnaires.

The rate of inconsistencies (i.e., where a response to a data item was inconsistent with the responses to one or more items on the same instrument) was partitioned into a rate for inconsistent but correct, and another rate for inconsistent and incorrect. The designations of correct and incorrect were determined by comparing the original data with the data obtained in the telephone interview. The discrete items TQ1 and TQ9 which were discussed in the previous section have especially large rates of inconsistent and incorrect responses. In addition to these two items, TQ33 and TQ66, which are discrete items located within routing patterns controlled by TQ32 and TQ51, respectively, have somewhat large rates of inconsistencies. For the discrete items, the rate of missing data was quite low, with 4.4 percent of the subsampled fail-edit questionnaires leaving TQ118 blank, and 2.4 percent leaving TQ90 blank--the highest nonresponse rates found. For the continuous items, nonresponse was a much greater source of error than inconsistencies. Items TQ141FA and TQ141FB, which requested total income in 1975 and 1976, respectively, each had nonresponse or bad data amounting to 23.9 percent of the fail-edit questionnaires. On a somewhat smaller scale, TQ89HA and TQ89HB, which requested the total cost to the student to live and go to school in 1974-75 and 1975-76, respectively, had nonresponse rates of 4.9 percent and 5.2 percent. Inconsistent and incorrect data occurred at the highest rates for TQ89HA and TQ89HB also, with 4.2 percent and 4.6 percent responding incorrectly. In general, though, one may say that the items with categorical responses had low rates of nonresponse and higher rates of inconsistencies, while the items with quantitative responses had the opposite situation of lower rates of inconsistencies and higher rates of nonresponse.

The effect of the inconsistent and incorrect responses in the discrete items can be seen from an examination of Table 4-1. Items TQ1 and TQ9 displayed the most inconsistent responses, and it is for these estimates that the largest values of the relative bias, bias ratios, and relative root mean square errors occur. For each of these two items, the proportions circling response options A, C, D, and G were estimated. The bias was negative, in general, indicating that the proportions would have been underestimated had

the inconsistencies not been corrected by telephone interview. The largest biases were recorded for TQ1G and TQ9G in which the proportion unemployed in 1976 and 1975 was underestimated by 14 and 23 percent, respectively, in the no imputation estimates. Many of the remaining large values encountered for the relative root mean square error were associated with the estimation of small proportions from subsets of the entire domain. These large values are to be expected since the variance of the estimates of small proportions will be large in relationship to the value of the estimate. Furthermore, by using only three-fourths of the full sample, the variances of these estimates will be greater than for the full sample. The effect on the variance of estimating small proportions is more pronounced when the estimation is being done for a subset of the entire population, such as those who attended school in 1974-1976 (the only individuals eligible to respond to TQ52 - TQ97), those married in the first week of October 1976 (the only individuals eligible to respond to TQ130 - TQ136), or those unemployed in the first week of October 1976 (the only individuals eligible to respond to TQ11 and TQ12). With respect to the bias ratio, the largest values appeared for items TQ1 and TQ9 and for items TQ12, TQ33, TQ66 and TQ90, which are items within routing patterns.

To gain a further understanding of the effects of the response errors to TQ1 and TQ9, some cross tabulations were computed for the total domain. For purposes of comparison, cross tabulations of some similar responses to TQ131 and TQ136 were also included. Note that TQ131 and TQ136 asks the respondent about his spouse's activities in the first week of October 1976 and in October 1975, respectively, using a format similar to that used for TQ1 and TQ9 which ask about the individual's activities. These tabulations are presented in Appendix G. One can easily see that the quality of those cross tabulations involving TQ1 and TQ9 is very poor. The relative bias for the estimate of the proportion of individuals who worked and took academic courses at a 2- or 4-year college in October 1975 (TQ9A and TQ9C both circled) was -24.70 percent. The bias ratio for this estimate was -14.76. Note that the cross tabulations for items TQ131 and TQ136 did not display this bias due to inconsistencies. However, for these two items, there were no similar items on the questionnaire that could be used for editing of logical inconsistencies.

In general, one can see the need for editing of the responses to TQ1 and TQ9 since the individual tabulations and cross tabulations involving these items were of poor quality. Because of the importance of these two items in

classifying an individual's work and academic activities, NLS resolved all inconsistencies using a telephone interview. It may be argued that the data in TQ131 and TQ136 should be used with caution since their format is similar to TQ1 and TQ9. The instrument did not provide a means for checking these items with respect to consistency so that faulty data could not be detected and corrected in the telephone interview.

The quality of the estimates obtained from the continuous data was better than that of the discrete data even though some of the items had large rates of nonresponse (see Table 4-1). The relative bias caused by inconsistencies was quite low which contributed to the fact that the no imputation estimates had reasonably small relative biases and relative root mean square errors. Nonresponse bias, even for TQ141 which had nonresponse amounting to around 13 percent, did not have a significant effect on the quality of the estimates for the total population. However, the bias ratio for 3 of the 6 means exceeded 0.50. The significance of this with respect to the use and interpretation of confidence intervals was discussed previously. The biases, though small in relation to the value being estimated, are large with respect to the standard deviation of the estimates. Thus, the total bias of the estimates is of concern and some procedures are necessary to correct for it.

2. Response Errors for Domains

As may be seen from an examination of Table 4-2 and the tables in Appendix F, the patterns of response errors were basically the same for the domains composed of males, individuals of high quality, individuals with low socio-economic status (SES), individuals from the South, and blacks of average ability as the response error pattern was for the total population. A comparison of these tables should be made carefully as domain sample size has an effect on the bias ratio and relative root mean square error. For instance, the bias ratio of estimates for males may be expected to be lower than for the total population since the standard deviations of the estimates for males (which forms the denominator of the ratio) are larger than the comparable standard deviations of the estimates for the entire population. Thus, the smaller sample size of domains will result in a larger variance which will cause the bias ratio to decrease and the relative root mean square error to increase with respect to that of the total population. In comparing estimates

for domains of different sizes and in comparing estimates for different items within the same domain (not all domain members answer each item because of the presence of routing patterns), the bias ratio and root mean square error should be used cautiously because of the effect due to sample size. The remainder of this section discusses various aspects of response errors using examples from domains.

The comparison between the quality of data for individuals of high ability and the entire population gives unexpected results. One's intuition might suggest that high ability individuals would have less trouble than the general population in understanding and responding to the instructions in the instrument. Referring back to Table 4-2, one notes that the average of the absolute relative measurement error biases for the discrete items is 2.31 percent for high ability individuals as opposed to 2.11 percent for the entire population. Similarly, for the continuous items, the average of the absolute relative measurement error biases is 0.55 percent for the high ability individuals as opposed to 0.50 percent for the entire population. Since the item response rates were essentially equal for the two domains, it is likely that the difference in the average quality of the data with respect to relative bias can be attributed to measurement error rather than nonresponse.

An exception to this result occurs for Item TQ118. A large increase to -13.67 percent was seen in the relative bias for the no imputation estimate of the proportion of high ability individuals responding "2" to TQ118 (indicating that since October 1974 they had served in the National Guard or Reserves). Since the experimental data set had no inconsistent, incorrect responses to this item, this bias was due entirely to nonresponse and illustrates how even a small rate of item nonresponse (approximately 2 percent of the full NLS data set) can have a serious effect when a small proportion (in this case 0.41 percent) is being estimated.

As may be seen in Table 4-2, the average quality of the data for blacks tended to be somewhat worse than that observed for the entire population. Much of the difficulty appears to be in the interpretation of routing patterns where large measurement error relative biases were observed (28.57 percent for response 2 of TQ90 and 18.60 percent for response 2 of TQ33 as seen in tables presented in Appendix F). These larger measurement error biases lead to larger values for the relative bias of the no imputation estimates and contribute to the larger values of the relative root mean square

error. The effect of bias in conjunction with a small size can be seen in the relative root mean square errors for the discrete estimates where only 16 of the 51 estimates have relative root mean square errors of 5 percent or less; whereas 34 of the estimates for the total population have relative root mean square errors of 5 percent or less.

Two of the more striking examples of the effect of measurement error bias occurred for the estimates of the proportions of blacks of average ability circling TQ1G, indicating they were unemployed in October 1976 and October 1975, respectively (see Appendix F). For these proportions, the relative biases of the no imputation estimates were -27.42 and 46.85 percent, respectively. If telephone editing had not been used to correct the inconsistencies for these items, the proportion of black individuals unemployed in October 1976 and October 1975 would have been estimated as 11.32 and 5.97 percent instead of the 15.60 and 11.23 percent estimates obtained after editing.

The examples given above illustrate the effect that measurement error and nonresponse bias can have in the presence of samples of different sizes. The most surprising aspect of the examination of response errors by domain was that there is little variation in the pattern of errors across domain. Minority groups such as blacks and Hispanics tended to have data of lesser quality with respect to relative bias than the general population, but these differences were not major (see Table 4-2). The overall quality of the data with respect to relative root mean square error was rather low for many domains, but this was predominately a function of small sample sizes.

B. Comparison of the Performance of Hot Deck and Weighting Class Estimators with That of No Imputation Estimates

It is clear from the previous discussion that for discrete items in general and for the continuous items within routing patterns, logical inconsistencies occurring in the data can have a serious effect on the bias. For instance, if all missing data were replaced by the true value using either an imputation procedure or telephone follow-up, the measurement error bias associated with an individual failing to respond in a correct manner to the questions would still be present and could cause serious problems in interpreting the estimates obtained from some of the items. The focus of this investigation was to investigate nonresponse bias so the potential benefits of

logical editing to correct inconsistent data were not investigated. However, the hot deck and weighting class imputation procedures did force the response within a routing pattern to agree with the lead-in question. When an inconsistent response (or responses) was encountered within a routing pattern, the entire set of responses to the items within the routing pattern were replaced (see Sections C.2 and C.3 for further discussion). Thus, the performance of the two imputation procedures depends upon three factors: the amount of nonresponse bias in the estimates, the extent to which the imputation procedure reduces the nonresponse bias, and the degree to which replacing inconsistent responses within a routing pattern improves the quality of the estimates. These issues will be discussed with respect to the discrete items as a group and then with respect to the continuous items.

Tables presenting the relative bias (RB), the bias ratio (BR), and the relative root mean square error ($R\sqrt{MSE}$) of the no imputation (NI), hot deck (HD), and weighting class (WC) estimates for all items may be found in Appendix H, for these selected domains - total population, males, high ability individuals, blacks, individuals of low socioeconomic status, Southerners, and blacks of average ability. Further, Appendix I gives the RB, BR, and $R\sqrt{MSE}$ of these estimates for all domains for selected discrete items and for all of the continuous items.

1. The Success of the Nonresponse Imputation Procedures in Reducing the Total Bias of Estimates Associated with Discrete Items

An examination of these tables given in Appendices H and I reveals that the weighting class imputation procedure devised for use with discrete items almost uniformly produced estimates whose total error was greater than that of the hot deck and no imputation estimates. Part of the reason the weighting class imputation technique performed so poorly was that the number of nonrespondents to an item within each weighting class was so small (often as small as one or two individuals) that it was impossible to have the proportion of nonrespondents assigned each response equal the proportion of respondents who gave the response. Because of its obvious lack of efficacy in reducing the total error of the discrete items, the weighting class imputation procedure was not subjected to a lengthy analysis to compare the estimates with those produced when no imputation or editing procedure was used. The results of the use of the weighting class procedure are summarized in Table 4-3, however.

In general, the hot deck imputation procedure did appear to have some effect in reducing the bias of survey estimates. Table 4-3 gives the averages for all 51 estimated proportions of the absolute relative bias, the absolute bias ratio, and the relative root mean square errors by selected domains of interest. For almost all of these domains, the average absolute relative bias and the average absolute bias ratio are less for the hot deck estimates than for the no imputation estimates. For instance, the average absolute relative bias of the estimates for the total population is 1.92 percent as compared with 2.25 percent when no imputation is used. Similarly, the average absolute bias ratio is 0.83 for the hot deck estimates as compared with 0.91 for the no imputation estimates. The bias ratio would be expected to be less since the variance of the hot deck estimates is usually greater than that of the no imputation estimates reflecting the greater variability of the hot deck procedure. However, the fact that the average relative bias is smaller does indicate that over all the 51 estimates, the hot deck procedure is reducing the bias in general. The domains in which the hot deck estimates are not better on the average, tend to be the small domains such as race equal to Hispanic or Other. For those domains in which the hot deck estimates performed better, the average relative bias reduction was less than 0.5 percent. Much of the bias reduction resulting from the use of the hot deck technique was associated with a corresponding increase in the variance, so that the difference between the average values of the relative root mean square error for the two procedures is usually small (a tenth of one percent or less). Nine of the 25 domains had the average relative root mean square error less for the hot deck estimates, including the estimates based upon the total population where the average of the relative root mean square errors was 4.53 percent as opposed to 4.64 percent for the no imputation estimates.

Another way of comparing the hot deck procedure to the no imputation procedure is to count the number out of the 51 proportions in which the hot deck estimate has a smaller absolute relative bias or a smaller relative root mean square error. Table 4-3 presents this data with the number out of the 51 estimates for which the hot deck estimates have smaller absolute relative biases--abbreviated as NUMBER HD $|RB| < NI |RB|$ and the number which have

Table 4-3.--Comparison of the average performance of hot deck and weighting class estimates with that of the no imputation estimates for discrete items

Domain		Average NI |RB%|	Average HD |RB%|	Average WC |RB%|	Number HD|RB| < NI|RB|	Number WC|RB| <NI|RB|	Averag NI |BR|	Average HD |BR|	Average WC |BR|	Average NI R√MSE%	Average HD R√MSE%	Average WC R√MSE%	Number. HD R√MSE% <NI R√MSE%	Number WC R√MSE% <NI R√MSE%
Total		2.25	1.92	3.12	34	15	0.91	0.83	1.06	4.64	4.53	5.14	22	14
Sex:	Male	2.08	1.82	2.67	29	18	0.65	0.58	0.70	5.90	5.88	6.24	17	14
	Female	2.78	2.59	5.15	25	19	0.64	0.62	0.81	6.96	6.89	8.78	26	13
Ability:	Low	2.98	2.82	5.56	23	14	0.43	0.44	0.64	8.83	8.92	10.93	23	16
	Middle	2.83	2.45	3.49	25	14	0.64	0.57	0.70	7.07	7.26	7.49	21	17
	High	2.71	2.39	3.06	26	18	0.59	0.54	0.60	8.62	8.46	9.06	32	18
SES:	Low	2.50	2.41	3.72	24	13	0.49	0.47	0.61	7.02	7.27	8.17	15	12
	Middle	2.74	2.70	3.92	20	18	0.66	0.64	0.81	6.28	6.39	6.96	20	16
	High	2.73	2.40	3.11	35	17	0.65	0.58	0.69	8.18	8.03	8.51	30	24
Race:	Black	3.74	3.29	4.99	29	20	0.49	0.43	0.56	10.25	10.26	10.98	17	12
	White	2.16	1.89	2.83	24	12	0.74	0.70	0.88	5.23	5.13	5.53	22	14
	Hispanic	6.18	14.51	29.69	11	12	0.23	0.33	0.35	37.92	47.02	52.39	9	10
	Other	3.03	3.08	4.86	22	20	0.35	0.35	0.42	12.10	12.39	13.78	21	16
Region:	Northeast	2.86	2.40	3.99	27	12	0.51	0.45	0.59	9.19	9.20	9.98	20	12
	South	2.43	2.39	2.73	25	18	0.69	0.68	0.74	7.11	7.04	7.31	30	19
	North Central	2.74	2.61	3.45	20	19	0.59	0.55	0.67	6.23	6.25	6.73	15	11
	West	2.53	2.32	4.55	21	17	0.51	0.48	0.64	8.09	8.20	9.79	22	13
Race x Ability:														
Black:	Low	4.96	4.36	5.95	21	21	0.42	0.38	0.47	14.76	14.52	15.76	23	14
	Middle	3.69	4.16	5.47	18	8	0.34	0.40	0.42	21.99	22.59	26.72	16	7
White:	Low	2.73	2.38	4.78	25	11	0.26	0.29	0.43	12.13	12.18	14.11	21	12
	Middle	3.00	2.57	3.48	28	15	0.58	0.52	0.61	7.82	7.74	8.21	22	20
	High	2.77	2.35	3.06	31	20	0.57	0.50	0.57	8.64	8.82	9.40	31	17
Other:	Low	5.06	7.34	12.03	16	19	0.25	0.34	0.40	22.76	24.48	29.78	24	18
	Middle	3.68	3.10	4.38	12	7	0.20	0.20	0.24	22.12	22.91	23.68	7	8
	High	3.54	4.17	4.23	15	17	0.22	0.25	0.25	31.08	31.50	31.50	12	10

NOTE.--The domain estimates for blacks of high ability and cross tabulations involving Hispanics were not included in this table since there were too few in the sample to compute valid variance estimates. For the rest of the domains, the average of the absolute values of the relative biases expressed as a percentage (|RB%|), the average of the absolute values of the bias ratios (|BR|), and the average of the relative root mean square errors (R√MSE) are given. The acronym "Number HD|RB| < NI |RB|" refers to the number of estimates for which the absolute relative bias is less for hot deck (HD) than for no imputation (NI) out of the total of 51 estimates. Similarly, "Number HD R√MSE < NI R√MSE" refers to the number of estimates for which the relative root mean square error of the hot deck (HD) estimate is less than that of no imputation (NI) estimate. The acronyms "Number WC |RB| < NI |RB|" and "Number WC R√MSE%" < NI R√MSE%" have similar definitions with respect to weighting class (WC) and no imputation estimates.

smaller relative root mean square errors--abbreviated as NUMBER HD $R\sqrt{MSE}$ < NI $R\sqrt{MSE}$. For the entire population, 34 of the 53 hot deck estimates had smaller absolute relative biases than the corresponding no imputation estimate; whereas only 22 of the hot deck estimates had smaller relative root mean square errors.

In the sense of relative bias it is interesting to note that for only eight of the 25 domains were more than half of the hot deck estimates better than the no imputation estimates. Since for 20 of the 25 domains the hot deck estimates on the average were better with respect to relative bias, one can hypothesize that the hot deck procedure is making substantial gains in bias reduction for a few items where there is the most nonresponse; and/or that the procedure by which the hot deck removes inconsistent responses within routing patterns and replaces them with consistent responses is effectively reducing the measurement error associated with inconsistent responses within routing patterns. Nonresponse bias reduction is not likely to be the principal factor since the item nonresponse rate was low for all of the discrete items. However, for the discrete item displaying the most nonresponse--TQ118 with approximately two percent nonresponse--the hot deck procedure obtained less biased estimates of the proportions circling each of the three possible responses (see Appendix I). If one examines the average of the absolute relative biases and relative root mean square errors on an item by item basis (see Table 4-4), then one can see that the hot deck procedure is achieving most of its gains on the questions within routing patterns. Of the within routing pattern items; TQ12, TQ33, TQ52, TQ66, TQ90, TQ102, TQ131, and TQ136; items TQ90 and TQ136 are the only ones in which the hot deck estimates do not have a smaller absolute relative bias. Again, much of this bias reduction is compensated for by an associated increase in the variance so that the hot deck estimates for TQ66, TQ102, and TQ131 have larger relative root mean squares than do the no imputation estimates.

2. The Success of the Nonresponse Imputation Procedures in Reducing The Total Bias of Estimates Associated with Continuous Items

The average values over all six continuous items of the absolute relative bias, the absolute bias ratio, and the relative root mean square error are given in Table 4-5 for the domains studied in this investigation.

Table 4-4.--A comparison of the hot deck (HD) and no imputation (NI) estimates on an item by item basis

Item	Average of the absolute relative biases		Average of the relative root mean square errors	
	NI	HD	NI	HD
1	5.86	5.84	6.71	6.70
9	7.85	7.87	9.16	9.22
10	1.65	1.79	3.73	3.93
12	2.52	1.67	5.27	5.23
29	0.22	0.53	2.32	2.30
33	6.19	1.74	7.54	5.08
51	0.46	0.66	1.34	1.42
52	0.62	0.31	1.47	1.14
66	2.95	2.93	3.45	3.66
90	2.19	2.58	5.29	5.38
101	0.39	0.10	1.35	1.31
102	0.69	0.67	3.07	3.15
118	1.08	0.14	4.89	4.91
129	0.10	0.12	2.66	2.67
131	0.09	0.17	5.56	5.61
136	0.19	0.13	4.30	4.32

Table 4-5.--Comparison of the average performance of hot deck and weighting class estimates with that of the no imputation estimates for continuous items

Domain		Average NI |RB%|	Average HD |RB%|	Average WC |RB%|	Average NI |BR|	Average HD |BR|	Average WC |BR|	Average NI $R\sqrt{MSE}$%	Average HD $R\sqrt{MSE}$%	Average WC $R\sqrt{MSE}$%
Total		0.80	0.76	0.86	0.64	0.46	0.64	1.29	1.46	1.40
Sex:	Male	1.01	0.94	1.15	0.50	0.39	0.53	1.87	2.05	2.03
	Female	0.43	0.65	0.61	0.26	0.33	0.42	1.59	1.84	1.69
Ability:	Low	1.42	2.02	1.92	0.37	0.36	0.55	3.26	5.41	3.38
	Middle	0.79	0.90	1.18	0.35	0.32	0.41	1.97	2.02	2.19
	High	0.61	0.61	0.53	0.32	0.31	0.30	1.80	1.84	1.72
SES:	Low	1.41	1.55	1.50	0.54	0.59	0.57	2.50	2.82	2.53
	Middle	0.58	0.52	0.85	0.38	0.26	0.54	1.38	1.79	1.57
	High	0.78	0.76	0.88	0.37	0.34	0.43	1.97	2.14	2.00
Race:	Black	2.01	1.98	2.04	0.62	0.40	0.41	4.02	4.43	4.06
	White	0.72	0.61	0.72	0.55	0.33	0.50	1.30	1.49	1.36
	Hispanic	9.36	7.75	8.90	0.48	0.40	0.65	17.28	17.12	14.96
	Other	1.19	1.97	1.43	0.28	0.54	0.33	3.51	3.84	3.58
Region:	Northeast	1.28	0.74	0.87	0.49	0.28	0.35	2.54	2.48	2.33
	South	0.38	0.65	0.54	0.26	0.38	0.34	1.50	1.67	1.51
	North Central	1.50	2.06	1.76	0.66	0.74	0.68	2.60	3.11	2.80
	West	0.51	0.35	0.73	0.23	0.08	0.33	2.30	3.33	2.23
Race x Ability:										
Black	Low	4.72	5.42	4.80	0.67	0.67	0.71	8.15	8.99	7.77
	Middle	1.27	0.92	2.20	0.22	0.14	0.39	6.45	6.61	6.47
White:	Low	0.69	1.35	0.69	0.21	0.31	0.30	3.71	7.49	3.41
	Middle	0.72	0.79	1.09	0.31	0.25	0.35	2.03	2.09	2.17
	High	0.63	0.58	0.48	0.33	0.29	0.24	1.79	1.83	1.71
Other:	Low	2.85	3.75	2.47	0.33	0.52	0.30	7.98	8.16	7.20
	Middle	2.86	2.78	2.64	0.28	0.30	0.28	7.25	7.26	7.14
	High	1.21	1.65	1.54	0.20	0.29	0.28	7.08	7.74	7.41

NOTE.--The domain estimates for blacks of high ability and cross tabulations involving Hispanics were not included in this table since there were too few in the sample to compute valid variance estimates. For the rest of the domain, the average of the absolute values of the relative biases (|RB%|), the average of the absolute values of the bias ratios (|BR|), and the average of the relative root mean square errors are given for the no imputation (NI), hot deck (HD), and weighting class (WC) estimates.

The hot deck and no imputation estimates are more or less comparable with respect to the absolute relative bias, with the hot deck estimates having a slightly smaller average relative bias for many of the domains, including the total. For many domains, the weighting class estimates have slightly larger average relative biases than both the no imputation and the hot deck estimates. The average bias ratio for the no imputation estimates is greater in general than that found for the hot deck and weighting class estimates. This reflects the greater variability of the hot deck and weighting class procedure which results in a larger denominator for the ratio. The final measure of quality of the data--the average value of the relative root mean square errors--is smallest for the no imputation estimates for 16 of the 25 domains, including the total. It is interesting to note that although the weighting class estimates did not exhibit the bias reduction potential of the hot deck estimates, the average relative root mean square error was less for the weighting class estimates as compared with the hot deck estimates for 23 of the 25 domains studied. In comparison with the no imputation estimates, the weighting class estimates did better with respect to average bias and average relative root mean square error for the smaller domains.

The six continuous items over which averages were taken were quite diverse and the imputation procedures were different for those which were within routing patterns. To gain a futher understanding of the effect of using the imputation procedures on continuous data, the estimates from these items were evaluated separately. Tables giving the domain estimates and their relative bias, bias ratio, and relative root mean square error for each of the six continuous items may be found in Appendix I.

The data items, TQ15 and TQ16, were related items nested within the routing pattern controlled by TQ10. These items requested the hours worked per week and the average weekly salary in October 1976, respectively. Neither the hot deck nor the weighting class procedure performed in a superior manner with respect to the no imputation estimates. Over all domains, the average absolute relative bias for TQ15 was 0.11 percent for the no imputation estimates as compared to 0.46 percent for the hot deck estimates and 0.28 percent for the weighting class estimates. Similarly, the no imputation estimates were better with respect to the average relative root mean square error with 1.16 percent as opposed to 1.37 percent for the hot deck estimates and 1.27 percent for the weighting class estimates. The same pattern of results was

observed for TQ16. The average absolute relative bias over all 25 domains studied was 0.23 percent for the no imputation estimates as compared with 0.46 percent for the hot deck estimates and 0.27 percent for the weighting class estimates. The average relative root mean square errors were 2.29 percent for the no imputation estimates and 2.38 and 2.33 percent, respectively, for the hot deck and weighting class estimates. Note that for both TQ15 and TQ16, the weighting class estimates had smaller absolute relative biases and smaller relative root mean square errors on the average than did the hot deck estimates.

Items TQ89HA and TQ89HB requested the individual to estimate the total amount it cost him to live and go to school in 1974-75 and 1975-1976, respectively. These items were nested within the routing pattern controlled by TQ51. Even though the only difference between these two items is the time period being referenced, the results of the comparison of the hot deck and weighting class estimates with the no imputation estimates were different for these items. For TQ89HA, the smallest relative bias for the total population was that of the hot deck estimate with 0.88 percent as opposed to 1.20 percent for the no imputation estimate and 1.37 percent for the weighting class estimate. Also, the relative root mean square error at 1.79 percent was less for the hot deck estimate for the total populatic than the no imputation estimate (1.81 percent) and the weighting class estimate (1.98 percent). For TQ89HA, the smallest relative bias for the total estimate was the 2.38 percent of the no imputation estimate as compared with 2.59 percent for the hot deck estimate and 3.04 percent for the weighting class estimate. The no imputation estimate of the total also had the smallest value of the relative root mean square error at 2.86 percent as compared with 3.60 percent for the hot deck estimate and 3.44 percent for the weighting class estimate.

With respect to the average over all 25 domains included in this investigation, slightly different results are noticed. For TQ89HA, the hot deck estimates had the least value for the average absolute relative bias with 2.70 percent, compared to 3.33 percent for the no imputation estimates and 3.14 percent for the weighting class estimates. For TQ89HB, the no imputation estimates had the least value for the average absolute relative bias with 3.78 percent as compared to 4.27 percent for the hot deck estimates and 4.49 for the weighting class estimates. With respect to the average value of the relative root mean square error, the weighting class estimates were better for

TQ89HA with an average of 5.55 percent over all domains; whereas, the no imputation estimates averaged 5.93 percent and the hot deck estimates averaged 6.04 percent. For TQ89HB, the no imputation estimates had the smallest average relative root mean square error of 7.26 percent as opposed to 9.22 percent for the hot deck estimates and 7.39 percent for the weighting class estimates. Note that for both TQ89HA and TQ89HB as with TQ15 and TQ16, the weighting class estimates had smaller relative root mean square errors on the average than did the hot deck estimates.

The final two continuous items included in the investigation were TQ141FA and TQ141FB which requested the total income of the individual and his spouse in 1975 and 1976, respectively. These two items were the only continuous items included in this study which did not fall within a routing pattern. Whereas the interpretation of the results for the four items within routing patterns was not particularly clear, the results for these two items clearly shows the weighting class estimates superior to the no imputation and hot deck estimates with respect to their relative bias and with respect to their relative root mean square error. From examining the table for TQ141FA in Appendix I, one can see that for 16 of the 25 domain estimates the weighting class estimates have smaller absolute relative biases than the no imputation estimates; however, only 9 of the hot deck estimates are better than the corresponding no imputation estimate with respect to the relative bias. For TQ141FB, 17 of the 25 weighting class domain estimates are superior to the corresponding no imputation estimates; whereas only 12 of the hot deck estimates are superior to the no imputation estimate with respect to the relative bias. For TQ141FA, the weighting class estimates are also better in terms of the average of the absolute values of the relative biases with 1.27 percent as compared to 1.48 percent and 1.49 percent for the no imputation and hot deck estimates, respectively. For TQ141FB, the no imputation estimates had the smallest average at 0.64 percent for the absolute relative bias, followed by the weighting class estimates at 0.72 percent and the hot deck estimates at 0.84 percent. The best measure of the quality of the estimates is the relative root mean square error. It is with respect to this quantity that the weighting class estimates are best for both items. For both totals and for 19 of the 24 domain estimates for TQ141FA and for 20 domain estimates for TQ141FB, the weighting class estimates have smaller relative root mean square errors than the no imputation estimates. For the hot deck procedure, six of

the domain estimates for TQ141FA and the total and four other domain estimates for TQ141FB are better than the no imputation estimates with respect to the relative root mean square error. Over all 25 domains, the average relative root mean square error for TQ141FA was 3.43 percent for the no imputation estimates and 3.95 percent for the hot deck estimates. For TQ141FB, the weighting class estimates had an average relative root mean square error of 2.73 percent; the average for the no imputation estimates was 2.90 percent; and for the hot deck estimates, 3.18 percent.

It is interesting that the weighting class estimates were clearly superior to the no imputation estimates for TQ141FA and TQ141FB but not for the other four continuous items (which were different in that they were found within routing patterns). However, the weighting class estimates for all six items were better than the hot deck items with respect to the average relative root mean square error, suggesting that the weighting class imputation procedure is more suitable as an imputation device when means are being estimated. For the items within routing patterns, one might hypothesize that the weighting class estimates would have been better or comparable to the no imputation estimates if the procedure had been implemented differently for the routing pattern when one or more responses were in logical disagreement to the lead-in question. A check of this procedure for two very small weighting classes in the data base revealed that much good data was being discarded by this procedure. Furthermore, the quality of the weighting class estimates of the means for continuous items within routing patterns would be expected to suffer because of the poor quality of the adaptation of the weighting class procedure used for discrete data. When a routing pattern had a missing response for the lead-in question (which was always an item with categorical or discrete responses), the response to the lead-in question was first imputed and then responses to the items within the routing pattern were imputed based upon the imputed response to the lead-in item. Since the weighting class procedure as applied to discrete items was more biased, one would expect that this bias for the responses to lead-in items would also have an effect on the bias of the estimates for continuous items within the routing pattern.

3. Comparison of Balance Repeated Replication and Taylor Series Linearization Variance Estimates

To determine the effect of ignoring imputation in computing variance estimates, two sets of variance estimates were computed for each set of survey

estimates. First, the Taylor Series linearization estimate for the variance of a ratio was computed using STDERR, an RTI package (see Appendix E for variance estimation formulas). This package calculates the standard approximation for the variance of a ratio in terms of the variance-covariance matrix of the numerator and denominator totals. Second, an estimate of the variance of the ratio estimate was obtained using the balanced repeated replication (BRR) technique which allows one to account for the variability induced by the imputation of missing data (see Appendix D).

For the no imputation estimates obtained using the full experimental data set (NI estimates) and the experimental data set with all inconsistent data removed (NIC estimates), the two variance estimates should be equal since no imputation is occurring and hence, they are both measuring the same variability. The variance estimates for the NI and NIC estimates are given in Appendix J for the estimates from the following domains: total population, males, individuals of high ability, individuals with low socioeconomic status, blacks, Southerners, and blacks of average ability. To compare the two sets of variance estimates, the ratio of the standard deviation of the estimate obtained using STDERR over the standard deviation obtained using BRR (SD Ratio) was also computed for the tables in Appendix J. An examination of the SD Ratios for the 51 discrete estimates and for the 6 continuous estimates indicates that the ratio is essentially one except for sampling variation. To see this more clearly, Table 4-6 presents the average SD Ratio for both the discrete and continuous items for each of the seven domains represented in Appendix J. The ratio of the standard deviations is more variable for the continuous items, reflecting the fact that only six estimates are being averaged for each domain. At 1.29, the SD Ratio for individuals of low socioeconomic status for the continuous NIC data is the largest ratio found.

It is interesting that almost all of the average values of the ratios of the standard deviations are greater than one. Since STDERR, unlike the BRR procedure, allows the use of finite correction factors at the school level, which can be significantly less than unity, one could expect the STDERR estimate to be smaller than the BRR estimate and hence to obtain SD Ratios less than one. The fact that this did not occur is indicative that the variability of the estimates is chiefly the result of within school rather than between school variation. In this case, the use of finite correction factors at the school level would have no important effect.

Table 4-6.--The average value of the ratio of the STDERR standard deviation to the BRR standard deviation (SD Ratio) for the no imputation estimates when inconsistent data is retained (NI) and when removed (NIC)

Domain	Average of the SD Ratio			
	Discrete items		Continuous items	
	NI	NIC	NI	NIC
Total population	1.03	1.01	1.01	1.01
Males	1.09	1.07	0.94	1.01
Individuals of high ability	1.07	1.07	1.06	1.18
Individuals with low socio-economic status	1.09	1.07	1.16	1.29
Blacks	1.03	1.03	1.01	1.05
Individuals from the South	1.04	1.03	1.18	1.13
Blacks of average ability	1.00	1.00	0.97	0.95

4. The Effect Ignoring Imputation has on Variance Estimation

Typically, most users of the hot deck and other imputation procedures ignore the fact that missing values have been imputed and use a standard software package which cannot distinguish between imputed and naturally occurring data in computing the variance estimates. This has the effect of magnifying the real sample size and ignoring the additional variability that the imputation procedure adds to the estimate. If one had a sample of 10,000 individuals and imputed data for 10 percent who were nonrespondents to an item, for instance, the estimate is actually being computed from the responses of the 9,000 individuals who answered the item. Ignoring the fact that imputation had occurred would result in an estimate obtained as if all 10,000 individuals had responded to the item. Also, the imputation of values for the 1,000 missing responses adds to the variability of the estimate, and the standard procedures cannot estimate this added variability.

Thus, one of the goals of this investigation was to determine what effect on the variance estimate would result from ignoring the fact that imputation of missing responses occurred. To do this, the variances of the survey estimates were computed using STDERR. The variance estimates obtained using STDERR do not reflect the added variability induced by the use of the imputation procedure. To obtain estimates of the variance of survey statistics which accounted for the added variability induced by imputation, a balanced repeated replication procedure was used in which the imputation procedure was applied to each independent half sample (see Appendix D). The comparison of these two variance estimates provides some insight into the effect on the variance of ignoring imputation. As can be seen from an examination of the tables in Appendix J which compare the STDERR and BRR variance estimators for continuous and discrete items when no imputation occurred, the STDERR and BRR variance estimates do not track extremely well. While the average of the ratio of the STDERR standard deviation to that of BRR is approximately one for the discrete and continuous items for these selected domains, there is considerable variation about the average. This variation obscures the quantification of the effect of ignoring imputation on variance estimates since the variance ignoring the imputation was estimated using STDERR and the variance estimate which accounted for the fact that imputation occurred was obtained by using BRR.

However, one can see some general effects that result from ignoring imputation. Table 4-7 gives the average of the ratio of the standard devia-

tions obtained using STDERR versus BRR for the 51 discrete estimates obtained when the hot deck procedure is used, and the ratios for the 6 continuous estimates obtained using both weighting class and hot deck. From examining the average ratio for the estimates from the discrete items, one can see that the ratio is essentially equal to one. Since the nonresponse rates for these items was very low, the imputation would not be expected to have a substantial impact on the variance. For the continuous estimates, a larger rate of nonresponse and hence more missing responses needed to have values imputed. The average ratios are less than one in many instances although perhaps not at a significant level. However, the response rates were fairly high except for TQ141FA and TQ141FB, so that little imputation would be occurring and the standard deviations would be expected to be approximately equal.

One can get a better understanding of the effect of ignoring imputation by comparing the standard errors for the 25 domains studied in this investigation when the hot deck and weighting class procedures are applied to TQ141FA, an income item which had a 13 percent nonresponse rate (see Table 4-8). The standard deviation estimated by STDERR using the usual formula for the variance of a ratio is not accounting for the variability induced by the imputation procedure. The differential nonresponse rates within domains results in varying values for the ratio of the standard deviations, but they are usually less than one. Some of the ratios are inexplicably large such as the ratio of 1.47 for blacks of low ability obtained when the weighting class procedure was used. Note that the standard deviations obtained using STDERR and BRR for the weighting class estimates are more nearly equal than those obtained using the hot deck procedure. This reflects the fact that the weighting class procedure induces less variation through imputation than does the hot deck procedure.

To summarize, when the nonresponse rate is large, the variance of sample means is underestimated when imputation is ignored in computing variance estimates. This underestimation effect will vary from domain to domain just as the nonresponse rate varies from domain to domain. The weighting class imputation procedure results in a less significant underestimation effect for the continuous items than the hot deck procedure, because the imputation procedure itself contributes less variability than that of the hot deck and hence, ignoring the variability added by weighting class imputation has less of an effect than when the hot deck procedure is used.

Table 4-7.--Average of the ratios of the STDERR standard deviation estimates to the BRR standard deviation estimates for the hot deck and weighting class procedures for selected domains

Domain	Discrete estimates	Continuous estimates	
	Hot deck	Hot deck	Weighting class
Total	1.02	0.86	0.94
Males	1.08	0.80	0.87
Individuals of high ability	1.06	1.03	1.05
Individuals with low socio-economic status	1.05	0.91	1.13
Blacks	0.97	0.83	0.95
South	1.07	1.08	1.13
Blacks of average ability	0.96	0.92	1.13

Table 4-8.--The ratio of the STDERR standard deviation estimates to the BRR estimates for TQ141FA

Domain		Hot deck			Weighting class		
		STDERR SD	BRR SD	SD Ratio	STDERR SD	BRR SD	SD Ratio
Total		67.93	84.55	0.80	63.61	70.11	0.91
Sex:	Male	79.90	95.41	0.84	76.01	95.18	0.80
	Female	101.89	172.30	0.59	95.47	138.95	0.69
Ability:	Low	175.90	223.51	0.79	149.76	150.34	1.00
	Middle	104.45	93.23	1.12	106.37	77.07	1.38
	High	122.64	115.58	1.06	111.48	106.99	1.04
SES:	Low	124.76	167.62	0.74	106.42	122.43	0.87
	Middle	88.52	92.87	0.95	82.66	81.72	1.01
	High	106.48	153.47	0.69	111.23	110.06	1.01
Race:	Black	157.84	183.67	0.86	147.76	156.84	0.94
	White	73.38	82.33	0.89	69.51	64.46	1.08
	Hispanic	853.14	965.70	0.88	674.42	980.63	0.69
	Other	280.55	298.39	0.94	268.93	263.13	1.02
Region:	Northeast	144.72	178.95	0.81	148.26	158.11	0.94
	South	133.94	118.67	1.13	121.88	84.12	1.45
	North central	124.51	211.63	0.59	106.64	145.55	0.73
	West	120.38	147.77	0.81	119.72	118.44	1.01
Race x Ability:							
Black:	Low	250.55	247.68	1.01	207.14	140.71	1.47
	Middle	362.80	417.60	0.87	353.30	382.02	0.92
White:	Low	207.43	247.73	0.84	160.00	145.49	1.10
	Middle	112.69	97.11	1.16	115.96	69.06	1.68
	High	124.96	99.68	1.25	113.68	98.19	1.16
Other:	Low	633.72	644.23	0.98	624.49	638.94	0.98
	Middle	381.12	432.27	0.88	356.86	376.07	0.95
	High	562.22	569.54	0.99	556.75	515.27	1.08

NOTE.--The blacks of high ability domain and the cross classifications of Hispanics by ability were omitted from this table since these domains had such a small sample size that valid variance estimates could not be obtained.

V. CONCLUSIONS

The results of this methodological study concerning missing and faulty data should be interpreted keeping two important facts in mind. First, the study was an empirical investigation based solely on 20 selected critical items from the Third Follow-up of the National Longitudinal Survey of the High School Class of 1972. The conclusions of this investigation refer to this special population of young adults and this type of survey instrument and may not be true when applied to other populations and to other types of surveys. Secondly, it should be emphasized that the study focused exclusively on the estimation of univariate means and proportions. If more complex statistical analyses were to be conducted, the conclusions of this study might not be valid.

In the experimental data set which contained the original responses to the 20 selected critical items before editing and telephone resolution, inconsistent data represented the most serious source of error in the survey estimates with the discrete items most susceptible to this kind of bias, especially TQ1, TQ9, and those items nested within routing patterns. The effect of this source of measurement error bias could be seen in many ways. The relative bias of many of the estimates obtained using the discrete data was over five percent. Due to the large sample size, the variance of the estimates was small so that even a moderate amount of bias became important because of its magnitude in relation to that of the variance. This effect was measured by the bias ratio for which many estimates had values of 0.5 or more. Finally, the best overall measure of the quality of the estimates is the relative mean square error, which became quite large for a few of the estimates.

It is clear that in analysing the NLS data base some attention should be given to the problem of resolving logical contradictions contained within an individual's responses to the items on the survey instrument. While some minor editing has been done with flags indicating violations of routing patterns, the majority of the editing has been left to the user. From the results of this study, one can see that merely discarding the inconsistent responses and coding these items as blank is not an acceptable solution. Rather,

the user of the NLS data base should design edit checks and choose procedures for the imputation or correction of missing and faulty data that are best suited for the items under study and for the type of analysis being conducted.

For the discrete items investigated in this study, the hot deck procedure did reduce the overall bias of the estimates, but much of the improvement may have been related to the editing procedure which removed inconsistent data within routing patterns and replaced these responses with data from an individual in the same weighting class who responded in a consistent manner. Except for this minor editing, the imputation procedures were not designed to correct for what turned out to be the most important source of error, the inconsistencies within an individual's responses. Procedures have been designed which will do both logical editing and imputation of responses for missing and logically erroneous data by Statistics Canada (Hill, 1978). A procedure such as their CAN-EDIT might be the best solution for reducing the bias resulting from missing or faulty data for discrete items.

The weighting class procedure devised for discrete items in this study did not work in practice. For categorical items with missing responses, the weighting class imputation technique randomly assigned responses in such a manner that within each weighting class the weighted proportion of nonrespondents assigned each response option was equal (as far as possible) to the proportion of respondents who gave that response (see Section II.C). In practice, the weighting class imputation technique performed poorly since the number of nonrespondents to an item within each weighting class was so small (often as few as one or two individuals) that it was impossible to have the proportion of nonrespondents assigned each response equal (even approximately) the proportion of respondents who gave the response. Retrospectively, one can suggest that the distribution of responses should have been estimated for each item within weighting classes (as before); then a response should be assigned randomly and independently for each missing value in such a manner that the probability of each of the response options being assigned for the missing value would equal the proportion of respondents from the same weighting class who circled that response option. Such a procedure might have proved to be competitive to the hot deck procedure in reducing the bias.

For the continuous items, the nonresponse rate was higher but the biasing effect of nonresponse was not of significance even for TQ141FA and TQ141FB where the nonresponse rates were 13 percent. The effect of inconsistencies

in the data set could be seen in the bias of the estimates for the continuous items as well, especially for those within routing patterns. The weighting class procedure was most effective in reducing the bias of the continuous estimates, but the reduction in the relative root mean square error was less than 0.5 percent in general.

At the start of this investigation, the level of nonresponse for the selected items before telephone editing was not known. Indeed, the reason why so many of the questionnaires failed edit was not known. It might have been of general scientific interest to have artificially generated larger nonresponse rates than those found in this study (for at least a few items). However, the results would not have been applicable to the NLS data set. In fact, the experimental data set was typical of one type of data set for which imputation is commonly used--high rates of response for categorical items, inconsistencies in responses associated with routing patterns and items which are similar, and higher rates of nonresponse for sensitive items such as income. In the past, analysts have behaved as if one should always impute for missing responses to "clean up" the data set. This study points out that such imputation can reduce rather than increase the accuracy of survey estimates.

For both the discrete and continuous data, the bias caused by nonresponse was insignificant. The bias resulting from individuals failing to interpret the questions correctly was large in relation to the nonresponse bias, and some attention should be given to this source of error. When using non-critical data items which do not undergo such rigorous manual editing, the NLS data user should devise logical editing and imputation procedures which fit his analysis to reduce such response errors. However, it should be emphasized that the data items being studied in this investigation were selected because data editors responsible for the manual editing of the questionnaire suggested that these items exhibited the largest rates of missing or faulty data. To correct for the errors in these critical data items, NLS utilizes the best procedure--the individual is telephoned and all missing faulty data is corrected.

VI. SUGGESTIONS FOR FURTHER RESEARCH

There are three topics related to item nonresponse that are of special interest and importance to users of the data from the National Longitudinal Survey. The topic of more immediate importance is the problem of missing ability scores. Approximately 30 percent of the sampled students for whom follow-up data was collected have missing ability scores. These students were enrolled in schools that refused to participate in the Base Year Survey in which the ability scores were obtained. Later many of these schools were included in follow-up surveys. Much of the important data that was contained in the Base Year instruments was obtained retrospectively during the first follow-up, but the ability scores could not be obtained. It is clear that some type of special purpose imputation procedure needs to be developed to replace the missing ability scores. An empirical investigation would be the best way to develop and test imputation procedures. One could create an experimental test file by using the data records for students with complete ability scores and removing the ability scores for all students within certain schools. The pattern of deletion in the experimental data set would be modeled after the actual pattern which occurs in the NLS data. Various imputation strategies could then be evaluated in terms of their bias and mean square error. Among the techniques that should be investigated would be hot deck, weighting class, and regression procedures for replacing missing data. The problem posed of imputing missing ability scores for NLS data is difficult because of the large rate of missing data, but alternative solutions could be evaluated using this empirically based procedure.

A second topic of interest to users of NLS data would be the effect of imputation on multivariate statistics. The present investigation focused almost exclusively on univariate means and proportions. However, users of the NLS data set typically use more sophisticated statistical procedures such as regression, factor analysis, and correlation studies, which contain many variables. The effect of item nonresponse is cumulative so that even though individual items have a large response rate, the number of records with complete responses to all items entering into the analysis may be so reduced that some type of adjustment becomes necessary. Since most of these procedures do not have software designed to adjust weights or perform any other adjustments needed to correct for the bias due to nonresponse, imputation of missing

values may be the only procedure that is feasible. For discrete variables, the effect of utilizing hot deck and the weighting class analog of hot deck discussed in Section V could be investigated. For continuous variables, research needs to be done on possible techniques to use. As discussed in Section IV, the hot deck imputations did not improve the estimates of means in general and a compensating increase in the variance of the hot deck estimates tended to counteract the bias reduction that was occasionally obtained. Predicting the effect of hot deck imputations on multivariate statistics is difficult, and thus some alternatives to hot deck should be investigated. A good procedure to consider would be a regression procedure which estimates the missing response based upon other completed data items. The weighting class imputation procedure should also be evaluated although it also has deficiencies. In the continuous case, the weighting class procedure imputed the estimated respondent mean for the same weighting class for the missing values. Thus, every nonrespondent within a weighting class would be imputed the same response. This is not a desirable feature of the procedure as far as variation and correlation statistics are concerned. However, if the number of weighting classes were made large so that the number of nonrespondents within each weighting class was small, then this weighting class imputation procedure might be a useful tool. One could also overcome the deficiency of the weighting class imputation procedure in its assignment of means within classes to all missing values by imputing the mean plus the product of a randomly generated normal standard deviate times the standard deviation of the observations within the weighting class. More sophisticated procedures might also be explored in which the distribution of responses to the quantitative item was estimated for each weighting class and then a response selected at random from this distribution to impute for missing values. All of these imputation procedures could be evaluated using the experimental data set constructed in this investigation. Since the responses for missing items were obtained by telephone interview, the bias and mean square error of the estimates could be obtained.

Finally, a third topic of interest to users of NLS data concerns the effect of missing data imputation for longitudinal surveys. In this investigation, no previous follow-up or base year data were used to form weighting classes or make logical imputations. This procedure of treating the data file as if it were cross-sectional is typically used in imputing missing data in

longitudinal surveys because no special techniques have been developed for such surveys. There is a serious need for further investigation concerning how one should use past and future follow-up data for imputation purposes and what effect such imputation will have on estimates of stability and change in items. An extension of this empirical investigation of imputation procedures could be made to account for the longitudinal nature of the data base. A two-pronged approach might be made to the problem of longitudinal imputation using the experimental data set constructed for this investigation. One could use all available data to create logical editing procedures to replace missing and inconsistent data in the experimental data set. Another technique needing investigation would be the use of previous follow-up data to form weighting classes for imputation purposes. Using the data sets developed for this investigation, one could determine the effect on the bias and variance of estimates when these two procedures are implemented. This investigation should include assessing these effects for longitudinal type estimates such as change variables. The present data set would allow the estimate of change variables for third follow-up versus base year responses for activity states. If fourth follow-up data were available, the effect of the imputed third follow-up data on later estimates of change and stability could also be evaluated.

These three topics are challenging examples of the problems associated with item nonresponse and are deserving of consideration. The first would furnish a good example of the effects of various imputation procedures when used on data with a high level of nonresponse. The second deals with the effect of imputation on inferences when more complex statistical analyses are performed. The third topic concerns the effect of imputation on the quality of change variables estimated using longitudinal survey data. All of these topics deal with problems which have not been dealt with extensively in the statistical literature, and deserve further investigation.

BIBLIOGRAPHY OF EXTERNAL SOURCES

Bailar, John C. and Barbara A. Bailar (1978). Comparison of two procedures for imputing missing survey values. Proceedings of the American Statistical Association, Section on Survey Research Methods, 462-467.

Bailar, Barbara A., Leroy Bailey, and Carol Corby (1978). A comparison of some adjustment and weighting procedures for survey data. Survey Sampling and Measurement, ed. N. Krishnan Namboodiri, Academic Press, New York, 175-198.

Chapman, David W. (1976). A survey of nonresponse imputation procedures. Proceedings of the American Statistical Association, Social Statistics Section, 245-251.

Cochran, William G. (1977). Sampling Techniques. John Wiley and Sons, New York.

Hartigan, J. A. (1975). Clustering Algorithms, John Wiley and Sons, New York.

Hill, Christopher J. (1978). A report on the application of a systematic method of automatic edit and imputation to the 1976 Canadian Census. Proceedings of the American Statistical Association, Section on Survey Research Methods, 474-479.

Levinsohn, Jay R., Louise B. Henderson, John A. Riccobono, and R. Paul Moore (1978). National Longitudinal Study: Base Year, First, Second, and Third Follow-up Data File Users Manual, National Center for Educational Statistics, DHEW.

McCarthy, P. J. (1966). Replication: An Approach to the Analysis of Data From Complex Surveys. National Center for Health Statistics, Series 2, No. 14.

Appendix A

EXECUTIVE SUMMARY

Appendix A

EXECUTIVE SUMMARY

In this empirical investigation of alternate item nonresponse adjustments, two methods which are frequently used by statisticians to adjust for bias induced by item nonresponse were studied. In particular, the hot deck and weighting class adjustment techniques were compared using data from the National Longitudinal Study of the High School Class of 1972 (NLS). Estimates obtained using these two techniques were compared with respect to their bias, variance, and mean square error to estimates obtained when no item nonresponse adjustments were made.

1. Construction of the Experimental Data Set

Rather than constructing a data set with artificially induced nonresponse, the decision was made to use actual data that contained item nonresponse for which the answers were subsequently obtained by telephone follow-up activities. By using data with naturally occurring patterns of item nonresponse, it was felt that a better understanding could be obtained of the actual problems associated with item nonresponse and the effect of nonresponse adjustments on the precision of the resulting estimators. Such a data set was constructed from the NLS Third Follow-Up (TFU) Survey by taking account of the following set of special circumstances. When certain items on the questionnaire had a missing response or an inconsistent set of responses for one or more of these critical items, the questionnaire was marked as having failed edit and the individual involved was telephoned and the missing response(s) were added. The data records for individuals whose questionnaires failed edit contained the responses to these critical items but did not indicate which responses were obtained by the telephone interview or what the original responses were.

In order to obtain this information on the responses before telephone resolution, the questionnaires were re-examined by data editors and the original responses to the selected critical items recorded. In all, a total of 10,850 questionnaires failed edit. For reasons of economy, a subsample of size 5,854 was selected for re-examination. Twenty key items chosen to be representative of the NLS instrument were examined on each of the selected questionnaires and a notation made as to whether or not telephoning was neces-

sary to obtain a response to that particular item. They include questions that have categorical responses including four items which allow the student to choose multiple response options. Many should have been answered by all survey participants; others applied to subpopulations such as those employed or those in school. Some questions were included that came from within routing patterns. Other sensitive questions, such as income, which had quantitative responses were included.

For each of these 20 items, the status of the response before telephone follow-up was determined. A summary of the status of the original responses to these items projected to the full sample is given in Table 1. Except for two multiple response option questions (TQ1 and TQ9) and four financial questions (TQ89HA, TQ89HB, TQ141FA, and TQ141FB), 95 percent of the questionnaires contained a response for an item that was consistent with other responses on the questionnaire. The highest rates of missing or blank responses were found for the income items, TQ141FA and TQ141FB. The multiple response items, TQ1 and TQ9, had the highest inconsistency rates; that is, TQ1 and TQ9 responses were most frequently in conflict with other questionnaire items. The "other" category in Table 1 was composed of those who failed an item but could not be contacted for telephone resolution.

The results presented in Table 1 are based upon the subsample of 5,854 questionnaires, drawn from the 10,850 that failed edit. Adding in the 9,235 questionnaires which passed edit (and hence had "consistent" answers for all of these items) would reduce all of these percentages by about one-half. Thus, the data set that was constructed of original responses had a relatively small rate of item nonresponse and a somewhat larger rate of inconsistent responses. Judging from where the inconsistencies occurred, the major problem other than TQ1 and TQ9 appeared to be associated with the routing pattern questions. Thus, in reconstructing the data set, the decision was made to leave the inconsistent data as observed rather than to code inconsistent items as blank. The hot deck problem and the weighting class imputation program were then written to force consistency on the data by requiring that the responses within a routing pattern agree with the lead-in question to the routing pattern. In computing the no imputation estimates, no attempt was made to force consistency on the data within records.

Table 1.--Classification of original responses to the twenty selected critical items

Item	Original response			
	Consistent	Blank	Inconsistent	Other
Discrete				
TQ1	92.4	0.2	6.7	0.7
TQ9	87.1	0.3	11.7	1.0
TQ10	96.0	0.9	2.7	0.4
TQ12	97.3	0.5	2.0	0.3
TQ29	99.0	0.5	0.3	0.2
TQ33	95.1	0.5	4.0	0.4
TQ51	97.5	0.9	1.2	0.4
TQ52	96.1	0.9	2.6	0.4
TQ66	94.5	1.1	4.0	0.5
TQ90	97.3	1.4	0.9	0.4
TQ101	98.5	1.0	0.2	0.3
TQ102	99.1	0.2	0.5	0.2
TQ118	97.1	2.4	0.1	0.4
TQ129	99.2	0.5	0.1	0.1
TQ131	99.5	0.2	0.2	0.1
TQ136	99.6	0.2	0.1	0.1
Continuous				
TQ15	98.6	0.6	0.5	0.3
TQ16	97.3	1.8	0.6	0.4
TQ89HA	92.9	2.6	3.8	0.7
TQ89HB	92.5	2.8	4.0	0.8
TQ141FA	82.9	12.9	2.4	1.9
TQ141FB	82.5	12.9	2.7	1.9

2. The Hot Deck and Weighting Class Imputation Techniques

The hot deck technique is flexible and relatively inexpensive to run with respect to computer time. Before using the hot deck imputation procedure, the data file was sorted into 87 weighting classes and then sorted according to strata and school within strata. The weighting classes which were based upon the student's race, sex, high school grades, high school curriculum, and parents' education were originally formed for total questionnaire nonresponse adjustments. These weighting classes were adapted for item nonresponse imputation by incorporating certain routing pattern lead-in questions. For each weighting class, an initial hot deck was formed by going through the data file and recording the first completed response to each item. Then, as the new data was processed, the weighting class to which each individual belonged was determined. If the item being examined was complete, then that individual's response replaced the response stored in the hot deck for that weighting class. Thus new responses were supplied for the hot deck as they appeared in the data file. When a questionnaire was encountered with a missing item, the response in the hot deck for that weighting class was imputed for the missing response. Note that since the data file was sorted into weighting classes before imputing for missing values, one would expect the hot deck technique to obtain much, if not all, of the bias reduction with a somewhat larger variance than would have resulted from the weighting class adjustment procedure. A more complete description of the hot deck imputation technique may be found in Chapman (1976) and Bailar, Bailey, and Corby (1978).

The second item nonresponse adjustment technique used was a "weighting class" imputation method. For continuous variables, the weighting class imputation technique simply replaced missing values by the estimated respondent mean for the weighting class containing the individual. When a mean or total is being estimated, this weighting class imputation technique results in the same estimate as that obtained when weight adjustments are made within weighting classes. For categorical items with missing responses, the weighting class imputation technique randomly assigned responses in such a manner that within each weighting class the proportion of nonrespondents assigned each response was equal (as far as possible) to the proportion of respondents who gave that response. Estimates of response level proportions will be the same (except for weight accumulations that cannot be expected to break precisely at the point desired) as that which would have resulted had a weighting

3. Analysis of the Data Set

Estimates of means and proportions were obtained using both imputation procedures for the whole population and domains defined by race, sex, ability, socioeconomic status, region, and race by ability.

The variance of the sample means and proportions was estimated by using the balanced repeated replication technique (BRR). BRR utilizes a balanced set of half-sample estimates to compute the sampling variance of complex statistics. The variability among the replicated estimates approximates the desired variance (McCarthy, 1966). In this investigation, 15 equal sized super strata were formed and the nonresponse imputation procedures were separately applied to the associated set of 16 balanced half samples, insuring that the resulting BRR variance estimates reflect the variability induced by the imputation procedures.

4. Summary of the Results

Due to the high item response rates, statistics computed from the pre-telephone data set had a relatively small amount of bias when compared with estimates using the post-telephone follow-up corrected and completed data. The bias that was observed resulted from two response error sources, namely, nonresponse and inconsistent responses. In this investigation, no general attempt was made to force consistency on the data within a student's record. An exception was made in the hot deck and weighting class imputation programs which did force the responses to items within a routing pattern to agree with the lead-in question to the routing pattern.

In general, the hot deck procedure did appear to reduce the bias caused by nonresponse for discrete items. The most improvement for bias was seen with respect to Item TQ118 which also exhibited the most nonresponse of the discrete items. Results for the proportion of students responding "3" to TQ are given in Table 2. The table gives the sample size for each domain, the "true" value of the statistic estimated using the telephone corrected and completed data file, the relative bias of the hot deck (HD) and no imputation (NI) procedures, and the root mean square errors of the procedures. Note that most, if not all, of the gain in bias reduction from hot decking was lost by a corresponding increase in the variance of the estimates.

The hot deck technique does not appear to perform very well for continuous items, including the income questions which had the highest rate of item nonresponse. The hot deck imputations did not improve estimates of means

Table 2.--A comparison of hot deck vs. no imputation for TQ118, response no. 3

Subpopulation		$\bar{Y}_{TRUE}$	NI RB%	HD RB%	NI $\sqrt{MSE}$	HD $\sqrt{MSE}$
Total		6.42	1.16	0.17	0.26	0.25
Sex:	Male	11.44	0.35	0.15	0.46	0.46
	Female	1.24	1.12	-0.08	0.15	0.15
Race:	Black	9.72	3.07	-1.31	0.96	0.96
	White	5.90	1.07	0.52	0.26	0.25
	Hispanic	8.61	1.53	12.96	5.02	5.12
	Other	6.23	0.03	-2.68	0.73	0.83
Ability:	Low	7.05	2.09	-0.49	0.59	0.53
	Middle	6.27	0.49	-0.22	0.32	0.35
	High	5.17	1.53	1.67	0.39	0.40
SES:	Low	8.33	0.94	0.30	0.61	0.62
	Middle	6.46	1.58	-0.10	0.31	0.30
	High	4.03	1.58	0.64	0.45	0.44
Region:	NE	5.36	1.35	0.32	0.92	0.90
	NC	5.96	0.71	-0.67	0.47	0.52
	S	7.17	0.97	0.28	0.28	0.30
	W	7.53	1.81	1.00	0.28	0.28
Race x Ability:						
Black:	Low	7.58	5.07	1.64	0.95	0.86
	Middle	12.21	-2.57	-5.46	1.81	2.45
White:	Low	6.67	1.44	-0.75	0.55	0.56
	Middle	5.90	0.92	0.44	0.40	0.41
	High	5.10	1.55	1.70	0.37	0.38
Other:	Low	7.49	0.70	-2.89	1.43	1.52
	Middle	4.70	1.02	0.00	1.32	1.29
	High	4.37	0.70	0.00	2.34	2.32

NOTE.--The domain estimates for blacks of high ability and all cross-classifications of Hispanics by ability are not presented since their small sample size prevented the computation of valid variance estimates. The estimate obtained using the telephone follow-up corrected and completed data ($\bar{Y}_{TRUE}$) is presented with the relative bias expressed as a percentage (RB%) and the root mean square error ($\sqrt{MSE}$) for the hot deck (HD) and no imputation (NI) estimates.

item nonresponse. The hot deck imputations did not improve estimates of means in general; and again, a compensating increase in the variance of the hot deck estimates tended to counteract the bias reduction that was occasionally obtained (see Table 3).

The weighting class imputation technique performed poorly when applied to discrete items. Part of the reason that the weighting class imputation technique compared poorly in relation to the hot deck and to the no imputation techniques for the discrete items was that the number of nonrespondents to an item within each weighting class was so small (often as few as one or two individuals) that it was impossible to have the proportion of nonrespondents assigned each response equal the proportion of respondents who gave the response. Overall, the weighting class imputation technique performed best for the continuous income items, TQ141FA and TQ141FB, which exhibited the most nonresponse. The weighting class estimates had somewhat smaller mean square errors than the no imputation and hot deck procedures (see Table 3).

Due to the manner in which the data file was constructed, it was relatively easy to identify inconsistent items. Recognizing that measurement errors caused by inconsistent responses constitute an important source of bias in the estimates obtained using the pre-telephone file, a new data file was constructed which retained all the inconsistent responses from the mail questionnaire but had missing items replaced by responses obtained in the telephone follow-up. The difference between statistics using this missing-data corrected file (referred to as $\bar{Y}_{ME}$ where ME stands for measurement error) and statistics obtained from the fully corrected telephone follow-up data file (referred to as $\bar{Y}_{TRUE}$) provides an estimate of the measurement error associated with inconsistent responses. Referring to Table 4 which compares these two statistics, one can see that the measurement error associated with inconsistent responses had a significant effect for TQ1 and TQ9 and cross tabulations involving these two items. TQ1 and TQ9 were multiple response option questions in which the students were instructed to "Circle as many as apply to you." The measurement error associated with these results was large and positive indicating that many students failed to circle all of the options that applied to them. Note that on the far right in Table 4 are the estimates $\bar{Y}_{NIC}$. These were obtained using no imputation on the pre-telephoning data set where inconsistent responses were recoded as missing data. Even for the questions in which inconsistencies were most common, i.e., TQ1 and TQ9, $\bar{Y}_{NIC}$

Table 3.—A comparison of hot deck vs. no imputation for TQ141FA

Subpopulation		$\bar{Y}_{TRUE}$	NI RB%	HD RB%	WC RB%	NI $\sqrt{MSE}$	HD $\sqrt{MSE}$	WC $\sqrt{MSE}$
Total		7040	-0.44	0.66	-0.15	76.25	96.54	70.99
Sex:	Male	6623	0.02	0.70	0.09	92.32	106.12	95.38
	Female	7460	-0.63	0.61	-0.39	146.36	178.25	141.99
Race:	Black	5946	-3.02	-0.62	-0.90	250.67	187.38	165.74
	White	7139	-0.54	0.67	-0.15	72.54	95.38	65.43
	Hispanic	8927	-4.01	-6.08	-8.71	1195.68	1108.22	1251.94
	Other	7176	2.53	2.63	1.42	337.94	353.39	282.31
Ability:	Low	7993	0.30	2.33	-0.53	165.32	291.28	156.29
	Middle	7574	0.74	0.28	0.25	100.94	95.61	79.44
	High	5327	-0.14	1.07	0.37	111.18	129.07	108.87
SES:	Low	7663	-0.70	1.18	-0.64	136.33	190.76	131.91
	Middle	7585	-0.47	0.49	-0.35	89.73	100.16	86.08
	High	5346	0.52	0.45	1.04	112.84	155.40	123.44
Region:	NE	6542	-1.50	-1.20	-0.62	189.22	195.43	163.25
	NC	7353	-0.79	0.80	-0.62	102.06	132.73	95.81
	S	7109	0.56	2.19	0.59	161.28	262.98	151.61
	W	7137	-0.04	0.34	0.00	132.00	149.82	118.44
Race x Ability:								
Black:	Low	6438	-4.11	-0.86	-2.44	320.17	253.81	210.98
	Middle	5648	3.26	1.77	3.61	446.45	429.52	433.24
White:	Low	8578	-0.80	2.23	-1.21	171.07	313.05	178.87
	Middle	7687	0.65	0.15	0.16	91.03	97.86	70.24
	High	5380	-0.29	1.05	0.17	101.50	101.30	98.62
Other:	Low	7731	9.84	7.04	6.55	1045.26	843.39	815.54
	Middle	7705	-0.94	1.05	-0.63	396.98	439.82	379.21
	High	4801	0.11	0.72	-0.10	520.95	570.62	515.29

NOTE.--The domain estimates for blacks of high ability and all cross-classifications of Hispanics by ability are not presented since their small sample size prevented the computation of valid variance estimates. The estimate obtained using the telephone follow-up corrected and completed data ($\bar{Y}_{TRUE}$) is presented with the relative bias expressed as a percentage (RB%) and the root mean square error ($\sqrt{MSE}$) for the no imputation (NI), hot deck (HD), and weighting class (WC) estimates.

Table 4.--A comparison of various estimators of proportions for the total population

Item	Response	$\bar{Y}_{TRUE}$	$\bar{Y}_{ME}$	$\bar{Y}_{NI}$	$\bar{Y}_{HD}$	$\bar{Y}_{NIC}$
TQ1A	1	72.29	70.55	70.56	70.55	72.98
TQ1C	1	17.16	17.09	17.10	17.11	15.62
TQ1D	1	4.12	4.42	4.41	4.41	3.78
TQ1G	1	9.19	7.94	7.94	7.94	7.96
TQ9A	1	67.82	63.33	63.29	63.29	67.15
TQ9C	1	32.15	31.59	31.63	31.63	29.02
TQ9D	1	3.96	3.97	3.99	3.98	3.23
TQ9G	1	7.00	5.43	5.42	5.41	5.40
TQ10	1	61.22	61.28	61 28	61.24	62.45
TQ10	2	13.06	13.01	13.03	13.06	11.81
TQ10	3	1.45	1.39	1.37	1.35	1.24
TQ10	4	24.27	24.32	24.33	24.35	24.51
TQ12	1	25.66	27.04	26.95	26.50	22.38
TQ12	2	7.20	7.19	7.24	7.23	7.59
TQ12	3	67.14	65.77	65.81	66.27	70.03
TQ118	1	92.68	92.68	92.59	92.67	92.63
TQ118	2	0.90	0.91	0.92	0.90	0.88
TQ118	3	6.42	6.41	6.50	6.43	6.49
TQ129	1	9.78	9.80	9.77	9.80	9.73
TQ129	2	45.95	45.95	45.92	45.92	45.93
TQ129	3	4.02	4.01	4.02	4.01	4.02
TQ129	4	40.25	40.24	40.30	40.28	40.32
Cross-Tabulations:						
TQ1AxTQ1C		10.21	9.09	9.10	9.11	9.29
TQ1AxTQ1D		2.97	3.12	3.11	3.11	2.75
TQ9AxTQ9C		17.24	12.99	12.98	12.99	13.68
TQ9AxTQ9D		2.68	2.35	2.36	2.35	2.14

NOTE.--The estimates given above were obtained using telephone follow-up corrected and completed data ($\bar{Y}_{TRUE}$), the data with missing responses completed but inconsistencies not corrected ($\bar{Y}_{ME}$), the pre-telephone data when no imputation ($\bar{Y}_{NI}$) and hot deck ($\bar{Y}_{HD}$) was used, and the pre-telephone data with inconsistencies removed and no imputation procedure used ($\bar{Y}_{NIC}$).

did not generally produce less biased estimates than $\bar{Y}_{NI}$ (no imputation) and $\bar{Y}_{HD}$ (hot deck) obtained using the pre-telephone data set with the inconsistencies left in.

5. Conclusions

In the past, analysts have behaved as if one should always impute for missing responses to "clean up" the data set. This study points out that such imputation can reduce rather than increase the accuracy of survey estimates. For most items, no significant gains in accuracy were achieved by using the imputation procedures. In part, this was because the response rates for the individual items were quite high. Also, the lack of important gains through imputation can be attributed to the fact that a reduction in bias was accompanied by a compensating increase in variance. If the item nonresponse rates had been higher and the associated nonresponse bias larger, the effect of bias reduction might have more than offset the corresponding increase in the variance of the statistics. For the continuous items where weighting class estimates could be compared with no imputation and hot decking, the weighting class estimates did have somewhat smaller mean square errors for the items with higher nonresponse rates. Unfortunately, accurate variance approximations for imputation-based statistics are difficult and costly to obtain so that most users will ignore the imputation in computing the variance. In a sense then, one disadvantage of using imputation techniques will be to underestimate the true variance of sample statistics, especially when the number of values being imputed is large. This underestimation could jeopardize the validity of confidence statements (Bailar and Bailar, 1978).

Finally, it should be emphasized that this study focused exclusively on the estimation of univariate means and proportions. If more complex statistical analyses were being conducted, such as regression or factor analysis, which used many variables, it would be much easier to analyze the data when the missing values have been imputed. Also, the effect of item nonresponse is likely cumulative so that even though individual items have a large response rate, the number of records with complete responses to all the items entering into the analysis may be so small that some type of imputation becomes necessary. The effects of imputation on inference when more complex statistical analyses are performed is a topic deserving considerable further investigation.

BIBLIOGRAPHY OF EXTERNAL SOURCES

Bailar, John C. and Barbara A. Bailar (1978). Comparison of two procedures for imputing missing survey values. Proceedings of the American Statistical Association, Section on Survey Research Methods, 462-467.

Bailar, Barbara A., Leroy Bailey, and Carol Corby (1978). A comparison of some adjustment and weighting procedures for survey data. Survey Sampling and Measurement, ed. N. Krishnan Namboodiri, Academic Press, New York, 175-198.

Chapman, David W. (1976). A survey of nonresponse imputation procedures. Proceedings of the American Statistical Association, Social Statistics Section, 245-251.

McCarthy, P. J. (1966). Replication: An Approach to the Analysis of Data From Complex Surveys. National Center for Health Statistics, Series 2, No. 14.

Appendix B

DATA CODING FOR THE ITEM
NONRESPONSE IMPUTATION STUDY

Appendix B

DATA CODING FOR THE ITEM NONRESPONSE IMPUTATION STUDY

1. Instructions to the Data Editors Re-examining the TFU Questionnaires

The following items from the NLS Third Follow-up will be examined in this investigation: 1, 9, 10, 12, 15, 16, 29, 33, 51, 66, 89a, 89b, 90, 101, 102, 118, 129, 131, 136, 141a, 141b. In both parts of questions 89 and 141 only the total will be examined.

Only questionnaires from the "fail-edit" or B batches will be examined. To select the mail questionnaires to examine, choose the first questionnaire in each batch and every other questionnaire in that batch until the questionnaires are exhausted. Repeat this process for each of the B batches containing mail questionnaires (these have batch numbers less than 500 and a B attached to the number). Every questionnaire obtained through a personal interview will be examined.

For each questionnaire selected, record the batch number and student I.D. number on one of the specially prepared Key Question Edit Problem Sheets (see Attachment B-1). For each of the item numbers circled on the special edit problem sheet, examine the Key Question Edit Problem Sheet enclosed in the questionnaire. If brown ink appears beside one of the circled items on this sheet, that question is to be examined. Conditional items within a routing pattern will also be checked when the routing item leading to the question is flagged. (Sometimes conditional items will be brown inked when the routing item is flagged and sometimes not.)

For each item circled on the special Key Question Edit Problem Sheet, the following coding will be used:

1. Leave the item blank if no telephoning was necessary.

2. If the item was left blank and an answer supplied by the telephone operator, code that item B for "blank."

3. If the original response was changed by the telephone operator, code that item R for "right."

4. If the original response was changed by the telephone operator, code that item by giving the original response.

5. If the answer is illegible or if a multiple response (when only one was possible) was given, code that item as BD for "bad data."

6. If a response of "don't know" was given, code the item DK.

7. For item number 141, a frequent error was that respondents would give their wages and then leave the others blank, including the total income. For this question, if the amount given was correct (or if zero, blank), but the respondent failed to total them, code the item BR for "blank but right entries given above."

8. If the telephone operator was unable to contact the individual, code the blank and inconsistent items with UTC for "unable to contact."

2. Original Responses to the 20 Selected Crucial Items

Following coding by the data editors, frequencies were computed for each item and each code. These frequencies are presented as percentages in Attachment B-2.

Key Question Edit Problem Sheet

Editor: _____

Telephone Operator: _____

BATCH # _____		Pass	Fail
	Edit	___	___
I.D.: _____	Tracing	___	___
	Telephone Edit	___	___

Check all key questions and important non-key questions which have caused a problem. When possible, briefly describe each problem.

___	① _____	___	*41** _____
___	⑨ _____	___	*42** _____
___	⑩ _____	___	*43** _____
___	*11** _____	___	*44** _____
___	⑫ _____	___	47 _____
___	13 _____	___	FFU43a _____
___	⑮ _____	___	SFU66 _____
___	⑯ _____	___	48 _____
___	㉙ _____	___	49a _____
___	32 _____	___	*49b** _____
___	㉝ _____	___	㊶ _____
___	34 _____	___	㊷ _____
___	35 _____	___	53 _____
___	36 _____	___	54 _____
___	37 _____	___	57 _____
___	40 _____	___	59 _____

Attachment B-1. Specially Prepared Key Question Edit Problem Sheet Used by Data Editors

61

65*

66

67

68

70

71

73

74

78*

83

84

89a

89 b

90

91

92

93

94

95

96

97

98*

99*

100*

101

102

103

104

108

109

118

119

126*

127*

129

130*

131

132*

133*

134*

135*

136

141a

141b

158

FFU25

FFU29a

FFU48a

FFU54a

FFU64

SFU 1

Section G: Background Information

Respondent's Name and Address

Respondent's Parent's Name and Address

Spouse's Name

*Important non-key questions.

Attachment B-2.--Item frequencies for the data codes used to describe the original response to the twenty critical items for the subsample of 5860 fail-edit questionnaires

Item	Data codes for original response							
	Consistent (C)	Blank (B)	Inconsistent but correct (R)	Inconsistent and incorrect (I)	Bad data (BD)	Don't know (DK)	Blank but right entries given above (BR)	Unable to contact (UTC)
TQ1	86.0	0.3	3.1	9.2	0.0	0.0	0.0	1.4
TQ9	76.1	0.5	4.6	16.9	0.0	0.0	0.0	1.8
TQ10	92.6	1.5	3.7	1.3	0.1	0.0	0.0	0.8
TQ12	95.0	0.9	2.4	1.2	0.0	0.0	0.0	0.5
TQ15	97.5	1.0	0.5	0.4	0.2	0.0	0.0	0.5
TQ16	94.9	3.0	0.5	0.5	0.2	0.0	0.0	0.7
TQ29	98.0	1.0	0.4	0.2	0.0	0.0	0.0	0.4
TQ33	90.9	0.9	3.9	3.5	0.0	0.0	0.0	0.8
TQ51	95.4	1.6	0.9	1.3	0.0	0.0	0.0	0.7
TQ52	92.9	1.6	2.9	1.8	0.0	0.0	0.0	0.8
TQ66	89.7	1.9	4.3	3.1	0.1	0.0	0.0	1.0
TQ89HA	86.8	4.8	2.8	4.2	0.1	0.0	0.0	1.3
TQ89HB	86.0	5.0	2.8	4.6	0.1	0.1	0.0	1.4
TQ90	95.1	2.4	0.5	1.1	0.1	0.0	0.0	0.7
TQ101	97.3	1.8	0.4	0.0	0.0	0.0	0.0	0.5
TQ102	98.3	0.4	0.3	0.7	0.0	0.0	0.0	0.3
TQ118	94.7	4.4	0.1	0.0	0.0	0.0	0.0	0.8
TQ129	98.6	0.9	0.1	0.1	0.1	0.0	0.0	0.3
TQ131	99.1	0.4	0.2	0.2	0.0	0.0	0.0	0.2
TQ136	99.2	0.4	0.2	0.0	0.0	0.0	0.0	0.2
TQ141FA	68.2	16.5	1.5	2.9	0.2	0.0	7.2	3.5
TQ141FB	67.6	17.5	1.5	3.5	0.1	0.0	6.3	3.6

Appendix C

THIRD FOLLOW-UP QUESTIONNAIRE

NOTICE

O.M.B. No. 051-S-76038
APPROVAL EXPIRES JUNE 30, 1978

OPERATION FOLLOW-UP

A LONGITUDINAL STUDY OF THE HIGH SCHOOL CLASS OF 1972

Third Follow-Up Questionnaire

Prepared for the
DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
BY RESEARCH TRIANGLE INSTITUTE ☐ RESEARCH TRIANGLE PARK, NORTH CAROLINA
FALL 1976

95

START

SECTION A: GENERAL INFORMATION

1. **What were you doing the first week of October 1976?**

(Circle as many as apply.)

TQ1A	Working for pay at a full-time or part-time job 1
TQ1B	Enrolled in graduate or professional school 2
TQ1C	Taking academic courses at a two- or four-year college 3
TQ1D	Taking vocational or technical courses at any kind of school or college (for example, vocational, trade, business, or other career training school) 4
TQ1E	On active duty in the Armed Forces (or service academy) 5
TQ1F	Homemaker 6
TQ1G	Temporary layoff from work, looking for work, or waiting to report to work 7
TQ1H	Other (describe: _____) 8

TQ2 2. **How would you describe your living quarters as of the first week of October 1976?**

(Circle one.)

Private house or mobile home 1
Private apartment 2
Dormitory or apartment operated by a school or college 3
Fraternity or sorority house 4
Rooming or boarding house 5
Military service barracks, on board ship, etc. 6
Other (describe: _____) 7

TQ3 3. **With whom did you live as of the first week of October 1976?**

(Circle one.)

By myself 1
With my parents 2
With my husband or wife 3
With parents and husband or wife 4
With other relatives 5
With person(s) not related to me 6

TQ4 4. **Which of the following best describes the location of the place where you lived in the first week of October 1976?**

(Circle one.)

In a rural or farming community 1
In a small city or town of fewer than 50,000 people that is not a suburb of a larger place 2
In a medium-sized city (50,000-100,000 people) 3
In a suburb of a medium-sized city 4
In a large city (100,000-500,000 people) 5
In a suburb of a large city 6
In a very large city (over 500,000 people) 7
In a suburb of a very large city 8
A military base or station 9

National Center for Education Statistics
Education Division
Department of Health, Education, and Welfare
Washington D.C. 20202

GENERAL INSTRUCTIONS

This questionnaire is divided into the following seven sections:

A. General Information
B. Work Experience
C. Education and Training
D. Military Service
E. Family Status
F. Experiences and Opinions
G. Background Information

Start by answering questions in Section A. You will need to answer the first question in each section, but you may not need to answer all the questions in every section. You may be able to skip most of some sections. We have designed the questionnaire with special instructions in red beside responses which allow you to skip one or more questions. Follow these instructions when they apply to you.

Read carefully each question you answer. It is important that you follow the directions for responding, which are:

- **(Circle one.)**
- **(Circle as many as apply.)**
- **(Circle one number on each line.)**

Sometimes you are asked to fill in a blank—in these cases, simply write your response on the line provided.

Where you are asked to circle a number, make a heavy circle. Here is an example:

Why did you leave high school? **(Circle one number on each line.)**

	My Reasons	NOT My Reasons
Graduated	(1)	2
Entered college	1	(2)
Went to work	(1)	2

Many questions ask what you were doing during a specific time period; for example, "What were you doing during the **first week of October 1976?**" Because it has been two years since we last heard from you, we also ask some questions about what you were doing in **1975.** As you go through the questionnaire, please watch for these time references and make sure you are thinking about the correct time period for each question.

This questionnaire is authorized by law 20 USC 1221e-1.

The Federal Privacy Act of 1974 requires that each survey respondent be informed of the following.

(1) Solicitation of information about the respondent as detailed in the questionnaire is authorized by Section 415 of the General Education Provisions Act as amended (20 USC 1226b).

(2) Disclosure of this information by the respondent is subject to no penalty for not providing all or any part of the requested information.

(3) The purpose for which this information is to be used is to provide statistics on a national sample of students as they move out of the American high school system into the critical years of early adulthood and relate these statistics to postsecondary educational costs and financial aid and other factors on the educational, work, and career choices of young adults.

(4) The routine uses of these data will be statistical in nature as detailed in 9 in Appendix B of the Departmental Regulations (45 CRF 56) published in the *Federal Register*, Vol. 40, No. 196, October 8, 1975.

When you complete this questionnaire, please place it in the post-paid, addressed envelope provided and mail it to:

OPERATION FOLLOW-UP
Research Triangle Institute
Post Office Box 12036
Research Triangle Park, North Carolina 27709

THANK YOU FOR YOUR COOPERATION

Q5 5. **Is this the SAME city or community where you lived in October 1974?**

Yes ..... 1 *GO TO Q. 8*
No ..... 2 *CONTINUE WITH Q. 6*

Q6 6. **How far is this from where you lived in October 1974?**

(Circle one.)

Less than 50 miles 1
50 to 99 miles 2
100 to 199 miles 3
200 to 499 miles 4
500 miles or more 5

Q7 7. **What was the main reason you moved to the place where you live now?**

(Circle one.)

To find or take a job 1
Was transferred 2
Other job-related reason 3
To go to school 4
To follow my parents or spouse to a new location 5
To follow another relative or friend to a new location 6
Wanted a better place to live 7
Other (specify: _____) 8

8. **Which of the following items do you have the use of as your own because you (or your spouse) have bought them or have been given them, or because they belong to your parents, roommates, dormitory, apartment building, etc.?**

(Circle one number on each line.)

		Have As My Own	Have But Don't Own	Don't Have Use Of
8A	a. Daily newspaper	1	2	3
8B	b. Dictionary	1	2	3
8C	c. Encyclopedia or other reference books	1	2	3
8D	d. Magazines	1	2	3
8E	e. Record player	1	2	3
8F	f. Tape recorder or cassette player	1	2	3
8G	g. Color television	1	2	3
8H	h. Typewriter	1	2	3
8I	i. Electric dishwasher	1	2	3
8J	j. Two or more cars or trucks that run	1	2	3

9. **Now please think back a year to Fall 1975. What were you doing in October 1975?**

(Circle as many as apply.)

9A Working for pay at a full-time or part-time job 1
9B Enrolled in graduate or professional school 2
9C Taking academic courses at a two- or four-year college 3
9D Taking vocational or technical courses at any kind of school or college (for example, vocational, trade, business, or other career training school) 4
9E On active duty in the Armed Forces (or service academy) 5
9F Homemaker 6
9G Temporary layoff from work, looking for work, or waiting to report to work 7
9H Other (describe: _____) 8

SECTION B: WORK EXPERIENCE

In this section, we would like to find out about the jobs you have held in the two-year period from October 1974 through October 1976. Include full-time jobs, part-time jobs, apprenticeships, on-the-job training, military service and so on.

We are interested in learning about the kinds of jobs you have held, the hours you worked and your income from these jobs, the level of your job satisfaction, and the relation of your training and education to your work experience. This information will help us better understand the movement of young people into the world of work and the reasons for changes in job situations.

JOBS HELD IN OCTOBER 1976

TQ10 10. **Did you hold a job of any kind during the first week of October 1976?**

(Circle one.)

- Yes, working full-time (35 hours or more per week) 1
- Yes, working part-time (34 hours or fewer per week) 2
- Yes, but on temporary layoff from work or waiting to report to work 3

GO TO Q 13, next page

- No 4

CONTINUE WITH Q. 11

11. **What were the reasons you were not working during the first week of October 1976?**

(Circle one number on each line.)

			My Reasons	NOT My Reasons
TQ11A	a.	Did not want to work	1	2
TQ11B	b.	Was full-time homemaker	1	2
TQ11C	c.	Going to school	1	2
TQ11D	d.	Not enough job openings available	1	2
TQ11E	e.	Required work experience I did not have	1	2
TQ11F	f.	Jobs available offered little opportunity for career development	1	2
TQ11G	g.	Health problems or physical handicap	1	2
TQ11H	h.	Could not arrange child care	1	2
TQ11I	i.	Other family responsibilities (including pregnancy)	1	2
TQ11J	j	Not educationally qualified for types of work available	1	2
TQ11K	k.	There were jobs but none where I could use my training	1	2
TQ11L	l.	Spouse preferred that I didn't work	1	2
TQ11M	m.	Other (specify) _____	1	2

TQ12 12. **Were you looking for work during the first week of October 1976?**

(Circle one.)

- Yes 1
- No, but DID look for work sometime during the month of September 1976 2
- No, and did NOT look for work at any time during the month of September 1976 3

GO TO Q 32, p. 7

13. **Please describe below the job you held during the first week of October 1976. (If you held more than one job at that time, describe the one at which you worked the most hours.)**

Q13A–D a. For whom did you work? (Name of company, business organization, or other employer)
(Write in): _____

b. What kind of business or industry was this? (For example, retail shoe store, restaurant, etc.)
(Write in): _____

c. What kind of job or occupation did you have in this business or industry? (For example, salesperson, waitress, secretary, etc.)
(Write in): _____

d. What were your most frequent activities or duties on this job? (For example, selling shoes, waiting on tables, typing and filing, etc.)
(Write in): _____

Q13E e. Were you:

(Circle one.)

An employee of a PRIVATE company, bank, business, school, or individual working for wages, salary, or commissions? 1
A GOVERNMENT employee (Federal, State, county, or local institution or school)? 2
Self-employed in your OWN business, professional practice, or farm? 3
Working WITHOUT PAY in family business or farm? 4

f. When did you start working at this job? TQ13FA (month) TQ13FB (year)

g. Are you currently working at this job?

TQ13GA Yes 1
No .....2 Date left: TQ13GB (month) TQ13GC (year)

14. **How did you find this job?**

(Circle as many as apply.)

14A	a.	School or college placement service 1
14B	b.	Professional periodicals or organizations 2
14C	c.	Civil Service applications 3
14D	d.	Public employment service 4
14E	e.	Private employment agency 5
14F	f.	Community action or welfare groups . 6
14G	g.	Newspaper, TV, or radio ads 7
14H	h.	Direct application to employers 8
14I	i.	Registration with a union 9
14J	j.	Relatives 10
14K	k.	Friends 11
14L	l.	Other (specify _____) 12

TQ16

15 15. **How many hours did you usually work at this job in an average week?**

_____ Hours per week

16. **In an average week, approximately how much did you earn at this job? (Report your gross earnings before deductions. If not paid by the week, please estimate.)**

$ _____ per week
(Earnings before deductions)

17. The following are some general things that people do on their jobs. About how much time did you spend on each in the average work day on your job?

(Circle one number on each line.)

		None	Very Little	Some	A Great Deal
TQ17A	Working with things (machinery, apparatus, art materials, etc.)	1	2	3	4
TQ17B	Doing paperwork (administrative, clerical, computational, etc.)	1	2	3	4
TQ17C	Working with ideas, thinking	1	2	3	4
TQ17D	Dealing with people (as part of the job)	1	2	3	4

18. a. About how many people were employed in the entire organization for which you worked? State or Federal employees give the approximate number of people in your Department, e.g., State, Commerce, Motor Vehicles, etc. Self-employed give the approximate number of your employees. (Circle one number in Column A.)

b. About how many of these people worked in the same plant or office as you? (Circle one number in Column B.)

	A. Total Organization	B. Same Plant or Office
I worked alone	1	1
Less than 10	2	2
10 - 99	3	3
100 - 499	4	4
500 - 999	5	5
1,000 - 2,499	6	6
2,500 and over	7	7
	TQ18A	TQ18B

TQ19 19. Please think of your supervisor or the person who had most control over what you actually did on the job. Which of the following best describes how closely this person supervised you?

(Circle one.)

My supervisor decided both what I did and how I did it ...1
My supervisor decided what I did, but I decided how I did it ...2
My supervisor gave me some freedom in deciding what I did and how I did it ...3
I was more or less my own boss within the general policies of the organization ...4
There was no such person ...5

TQ20 20. How many people did you supervise in your job? (Include all persons whose work you supervised as well as those for whose work you were held responsible.)

_____ people

21. **How satisfied were you with the following aspects of this job?**

(Circle one number on each line.)

		Very Satisfied	Satisfied	Dissatisfied	Very Dissatisfied
21A	a. Pay and fringe benefits	1	2	3	4
21B	b. Importance and challenge	1	2	3	4
21C	c. Working conditions	1	2	3	4
21D	d. Opportunity for promotion and advancement with this employer	1	2	3	4
21E	e. Opportunity for promotion and advancement in this line of work	1	2	3	4
21F	f. Opportunity to use past training and education	1	2	3	4
21G	g. Security and permanence	1	2	3	4
21H	h. Supervisor(s)	1	2	3	4
21I	i. Opportunity for developing new skills	1	2	3	4
21J	j. Job as a whole	1	2	3	4
21K	k. The pride and respect I received from my family and friends by being in this line of work	1	2	3	4

22 22. **Not including on-the-job or employer training, did you receive formal instruction to do this kind of work?**

No ..... 1 *GO TO Q. 27, next page*
Yes ..... 2 *CONTINUE WITH Q. 23*

23. **Where did you receive this training?**

(Circle as many as apply.)

23A	High school 1
23B	Vocational, trade, business, or other career training school 2
23C	Junior or community college 3
23D	Four-year college or university 4
23E	Military service 5
23F	Other (describe: _____) 6

24. **What were your experiences while working on this job?**

(Circle one number on each line.)

		My Experience	NOT My Experience
24A	a. I have been able to apply most of what I learned in school	1	2
24B	b. I would have liked more experience in my training before I started working	1	2
24C	c. I received training different from the way it was done on the job	1	2
24D	d. I was trained with tools or equipment not used on my job	1	2
24E	e. I could have gotten my job without the training	1	2
24F	f. I took coursework associated with my training which was not helpful in performing my job	1	2
24G	g. Most of what I did on the job I learned to do in school	1	2
24H	h. I consider myself doing as well as others with similar training	1	2
24I	i. I consider going to school and getting the training a wise choice	1	2

102

TQ25 **25. Were you hired for this job because your employer knew you had been trained in a school or college to do this kind of work?**

Yes 1
No 2
Don't know 3

TQ26 **26. Did the school at which you received your training for this job refer you to this job?**

Yes 1
No 2

TQ27 **27. Do you expect to be working in October 1977?**

No 1
Don't know ....2 } *GO TO Q. 29*
Yes .....3 *CONTINUE WITH Q. 28* →

TQ28 **28. Do you plan to work at the SAME KIND OF WORK?**

Yes 1
No 2
Don't know 3

TQ29 **29. Were you working at a second job in the first week of October 1976 at the SAME TIME as you held the job you described above?**

No .....1 *GO TO Q. 32*
Yes .....2 *CONTINUE WITH Q. 30*

TQ30 **30. How many hours did you usually work at this job in an average week?**

_____ Hours per week

TQ31 **31. In an average week, approximately how much did you earn at this job? (Report your gross earnings before deductions. If not paid by the week, please estimate.)**

$ _____ per week
(Earnings before deductions)

JOBS HELD IN OCTOBER 1975

TQ32 **32. Now please think back to Fall 1975. Did you hold a job of any kind during the month of October 1975?**

(Circle one.)

Yes, working full-time (35 hours or more per week) 1
Yes, working part-time (34 hours or fewer per week) 2
Yes, but on temporary layoff from work or waiting to report to work 3
} *GO TO Q 34, next page*

No .....4 *CONTINUE WITH Q. 33*

TQ33 **33. Were you looking for work during October 1975?**

(Circle one.)

Yes 1
No, but DID look for work sometime during the month of September 1975 2
No, and did NOT look for work at any time during the month of September 1975 3
} *GO TO Q 41, p. 9*

34 34. Is this the same job you held in October 1976 and reported in Q. 13?

(Circle one.)

Yes ..... 1 *GO TO Q. 36*

No, different job ..... 2 } *CONTINUE WITH Q. 35*

No, was not working in October 1976 ..... 3 }

35. Please describe below the job you held during October 1975. (If you held more than one job at that time, describe the one at which you worked the most hours.)

35A–D a. For whom did you work? (Name of company, business organization, or other employer)

(Write in): _____

b. What kind of business or industry was this? (For example, retail shoe store, restaurant, etc.)

(Write in): _____

c. What kind of job or occupation did you have in this business or industry? (For example, salesperson, waitress, secretary, etc.)

(Write in): _____

d. What were your most frequent activities or duties on this job? (For example, selling shoes, waiting on tables, typing and filing, etc.)

(Write in): _____

35E e. Were you:

(Circle one.)

An employee of a PRIVATE company, bank, business, school, or individual working for wages, salary, or commissions? 1

A GOVERNMENT employee (Federal, State, county, or local institution or school)? 2

Self-employed in your OWN business, professional practice, or farm? 3

Working WITHOUT PAY in family business or farm? 4

f. When did you start working at this job? TQ35FA (month) TQ35FB (year)

TQ37

36 36. How many hours did you usually work at this job in an average week?

_____ Hours per week

37. In an average week, approximately how much did you earn at this job? (Report your gross earnings before deductions. If not paid by the week, please estimate.)

$ _____ per week
(Earnings before deductions)

38. Are you currently working at this job?

TQ38A Yes ..... 1 *GO TO Q. 40, next page*

No ..... 2 Date left: TQ38B (month) TQ38C (year) *CONTINUE WITH Q. 39*

39. How important were the following as reasons for your leaving this job?

(Circle one number on each line.)

			Very Important	Somewhat Important	Not Important
TQ39A	a.	Poor pay or fringe benefits	1	2	3
TQ39B	b.	Lack of importance and challenge	1	2	3
TQ39C	c.	Poor working conditions	1	2	3
TQ39D	d.	Lack of opportunity for promotion and advancement with this employer	1	2	3
TQ39E	e.	Lack of opportunity for promotion and advancement with this line of work	1	2	3
TQ39F	f.	No or little opportunity to use past training and education	1	2	3
TQ39G	g.	Lack of security or permanence	1	2	3
TQ39H	h.	Dissatisfied with my supervisor(s)	1	2	3
TQ39I	i.	Lack of opportunity for developing new skills	1	2	3
TQ39J	j.	Unhappy with the job as a whole	1	2	3
TQ39K	k.	Moved to another location	1	2	3
TQ39L	l.	I was laid off or fired	1	2	3
TQ39M	m.	Went back to school or college	1	2	3
TQ39N	n.	Got married	1	2	3
TQ39Ø	o.	Had a baby	1	2	3
TQ39P	p.	Other family responsibilities	1	2	3
TQ39Q	q.	Left to obtain a better job	1	2	3
TQ39R	r.	Health problems or physical handicap	1	2	3
TQ39S	s.	Promotion or transfer within same organization	1	2	3
TQ39T	t.	Temporary or school-related job	1	2	3
TQ39U	u.	Other (specify: _____)	1	2	3

TQ40 40. Were you working at a second job during the month of October 1975 at the SAME TIME as the job you described above?

No 1
Yes 2

41. During the two 52-week periods from (a) October 1974 to October 1975 and from (b) October 1975 to October 1976 how many different employers did you work for altogether? (Count each employer only once, even if you had different jobs for the same employer.)

(a) October 1974-October 1975		(b) October 1975-October 1976	
TQ41A	Number of employers	TQ41B	Number of employers

42. During the same two 52-week periods from (a) October 1974 to October 1975 and from (b) October 1975 to October 1976, about how many weeks did you work altogether? (Count all weeks in which you did any work at all or were on paid vacation.)

(a) October 1974-October 1975		(b) October 1975-October 1976	
TQ42A	weeks	TQ42B	weeks

43. In each of these 52-week periods from (a) October 1974 to October 1975 and from (b) October 1975 to October 1976, were there any weeks in which you were NOT working and were looking for work, on layoff from a job, or waiting to report to work?

		(a) October 1974-October 1975	(b) October 1975-October 1976
TQ43NY	No 1		
	Yes 2	How many? TQ43A weeks	TQ43B weeks

44X* 44Y 44. What kind of work will you be doing when you are 30 years old? (Circle the one that comes closest to what you expect to be doing.)

(Circle one.)

a. CLERICAL such as bank teller. bookkeeper. secretary. typist. mail carrier. ticket agent 1
b. CRAFTSMAN such as baker. automobile mechanic. machinist. painter. plumber. telephone installer. carpenter 2
c. FARMER. FARM MANAGER 3
d. HOMEMAKER OR HOUSEWIFE ONLY 4
e. LABORER such as construction worker. car washer. sanitary worker. farm laborer 5
f. MANAGER. ADMINISTRATOR such as sales manager. office manager. school administrator. buyer. restaurant manager. government official 6
g. MILITARY such as career officer. enlisted man or woman in the Armed Forces 7
h. OPERATIVE such as meat cutter. assembler. machine operator. welder. taxicab. bus. or truck driver. gas station attendant 8
i. PROFESSIONAL such as accountant. artist. registered nurse. engineer. librarian. writer. social worker. actor. actress. athlete. politician. but not including public school teacher 9
j. PROFESSIONAL such as clergyman. dentist. physician. lawyer. scientist. college teacher 10
k. PROPRIETOR OR OWNER such as owner of a small business. contractor. restaurant owner 11
l. PROTECTIVE SERVICE such as detective. police officer or guard. sheriff. fire fighter 12
m. SALES such as salesperson. advertising or insurance agent. real estate broker 13
n. SCHOOL TEACHER such as elementary or secondary 14
o. SERVICE such as barber. beautician. practical nurse. private household worker. janitor. waiter 15
p. TECHNICAL such as draftsman. medical or dental technician. computer programmer 16
q. NOT WORKING 17

45 45. Do you think you will need more education or schooling than what you have at present in order to obtain this kind of work or to advance as you would like in your job or career?

No 1
Yes 2
Don't know 3

46 46. How satisfied are you with the progress you have made towards doing the kind of work you expect to be doing when you are 30 years old?

(Circle one.)

Very satisfied 1
Satisfied 2
Dissatisfied 3
Very dissatisfied 4

ɜe manual for coding instructions.

106

START

SECTION C: EDUCATION AND TRAINING

This section asks information about your training and education. We would like to find out about the schools you have attended during the last two years, from October 1974 to October 1976. This information, combined with information you have given us in earlier follow-ups, will help to give us a complete picture of your educational experiences since high school. (Persons in the military service should also answer the questions in this section.)

EDUCATIONAL PROGRESS AND PLANS

TQ47 **47. Since high school, had you earned any certificate, license, diploma or degree of any kind prior to October 1976?**

No ..... 1 *GO TO Q. 49*
Yes ..... 2 *CONTINUE WITH Q. 48*

48. What kind of certificate, license, diploma or degree have you earned?

		(Circle as many as apply.)	Date Received Month	Year	Area of Certificate, License, or Degree (For Example, Real Estate License, Shorthand Certificate, Degree in History)
TQ48AA	A certificate	1	TQ48AB	19 TQ48AC	TQ48AD
TQ48BA	A license	2	TQ48BB	19 TQ48BC	TQ48BD
TQ48CA	A 2-year or 3-year vocational degree or diploma	3	TQ48CB	19 TQ48CC	TQ48CD
TQ48DA	A 2-year academic degree	4	TQ48DB	19 TQ48DC	TQ48DD
TQ48EA	A 4-year or 5-year college Bachelor's degree	5	TQ48EB	19 TQ48EC	TQ48ED
TQ48FA	A Master's degree or equivalent	6	TQ48FB	19 TQ48FC	TQ48FD
TQ48GA	Other (specify: _____)	7	TQ48GB	19 TQ48GC	TQ48GD

49. a. As of the first week of October 1976, what was your highest level of education or training? (Column A)

b. As things stand now, how far in school do you think you actually will get? (Column B)

		TQ49A A. Had in October 1976 (Circle one.)	TQ49B B. Plan to get (Circle one.)
Finished high school		1	1
Vocational trade or business school	Less than two years	2	2
	Two years or more	3	3
College program	Less than two years of college	4	4
	Two or more years of college (including two-year degree)	5	5
	Finished college (four- or five-year degree)	6	6
	Master's degree or equivalent	7	7
	Ph.D., or advanced professional degree	8	8

50. With regard to your education and training during the last year you were in school, how satisfied as a whole were you with the following?

(Circle one number on each line.)

		Very Satisfied	Somewhat Satisfied	Neutral or No Opinion	Somewhat Dissatisfied	Very Dissatisfied
50A	a. The ability, knowledge, and personal qualities of most teachers	1	2	3	4	5
50B	b. The social life	1	2	3	4	5
50C	c. Development of my work skills	1	2	3	4	5
50D	d. My intellectual growth	1	2	3	4	5
50E	e. Counseling or job placement	1	2	3	4	5
50F	f. The buildings, library, equipment, etc.	1	2	3	4	5
50G	g. Cultural activities, music, art, drama, etc.	1	2	3	4	5
50H	h. The intellectual life of the school	1	2	3	4	5
50I	i. Course curriculum	1	2	3	4	5
50J	j. The quality of instruction	1	2	3	4	5
50K	k. Sports and recreation facilities	1	2	3	4	5

51 51. During the two-year period from October 1974 through October 1976 were you enrolled in or did you take classes at any school like a college or university, graduate or professional school, service academy or school, business school, trade school, technical institute, vocational school, community college, and so forth?

No ..... 1 *GO TO Q. 98, p. 22*
Yes ..... 2 *CONTINUE WITH Q. 52*

SCHOOL ATTENDANCE IN OCTOBER 1976

2 52. Did you attend school in the first week of October 1976?

No ..... 1 *GO TO Q. 66, p. 15*
Yes ..... 2 *CONTINUE WITH Q. 53*

53. What is the exact name and location of the school you were attending in the first week of October 1976? (Please print and do not abbreviate.)

School Name: TQ53A

City: TQ53B State: TQ53C

4 54. What kind of school is this?

(Circle one.)

Vocational, trade, business, or other career training school ... 1
Junior or community college (two-year) ... 2
College or university (four years or more) ... 3
Independent graduate or professional school (medical, dental, law, theology, etc.) ... 4
Other (describe: _____) ... 5

CONTINUE

55. When did you first attend this school? TQ55A (month) TQ55B (year)

56. Are you currently attending this school?

TQ56A
Yes 1
No .....2 Date left: TQ56B (month) TQ56C (year)

TQ57 57. During the first week of October 1976, were you classified by this school as a full-time student?

Yes 1
Don't know .....2 } *GO TO Q. 59*
No .....3 *CONTINUE WITH Q. 58*

58. What were your reasons for attending school part-time instead of full-time?

(Circle as many as apply.)

TQ58A a. Could not afford to go full-time 1
TQ58B b. Working full-time 2
TQ58C c. Working part-time 3
TQ58D d. Family responsibilities 4
TQ58E e. Taking job-related courses 5
TQ58F f. Taking courses for personal enrichment 6
TQ58G g. Undecided about career plans 7
TQ58H h. Too much pressure or strain with full-time load 8
TQ58I i. Health problems or physical handicap 9
TQ58J j. Other (specify: _____) 10

TQ59 59. During October 1976, about how many hours a week did your classes meet in the subjects or courses in which you were enrolled? Include time in lectures, shop, laboratories, etc.

_____ hours per week

TQ60 60. At that time how were you classified by your school?

(Circle one.)

Freshman (first-year undergraduate student) 1
Sophomore (second-year undergraduate student) 2
Junior (third-year undergraduate student) 3
Senior (fourth-year undergraduate student) 4
Graduate or professional student 5
Special student 6
Other classification (specify: _____) 7
My school doesn't classify students 8

161 61. As of the first week of October 1976, what was your actual or intended field of study or training area (for example, practical nurse, machinist, beautician, civil engineering, accounting, psychology, home economics, etc.)?

Please name the specific field or area:

(Write in): _____

162 62. Please select below the category which best describes this field or area.

(Circle one.)

Agriculture or Home Economics 1
Business (accounting, marketing, personnel management, etc.) 2
Office and Clerical (bookkeeping, stenography, general office, etc.) 3
Computer Technology (keypunch operator, programming, computer operations, etc.) 4
Education (elementary, special, physical, etc.) 5
Engineering (civil, electrical, mechanical, etc.) 6
Mechanical and Engineering Technology (automotive mechanic, machinist, construction, drafting, electronics, etc.) 7
Humanities and Fine Arts (music, religion, English, etc.) 8
Health Services (nursing, lab technician, occupational therapy, etc.) 9
Public Services (law enforcement, food service, recreation, beautician, etc.) 10
Physical Sciences and Mathematics (physics, geology, chemistry, etc.) 11
Social Sciences (psychology, history, economics, sociology, etc.) 12
Biological Sciences (zoology, physiology, anatomy, etc.) 13
Professional Program (medicine, dentistry, law, theology, etc.) 14

OTHER field or area (specify: TQ62FS) .. 15

UNDECIDED 16

163 63. This (above) is:

(Circle one.)

A vocational program 1
An academic program 2
A professional program 3
Other (specify: _____) ... 4

64. As of the first week of October 1976, what kind of certificate, license, diploma, or degree were you studying for?

(Circle as many as apply.)

164A None 1
164BA A certificate (specify in what: TQ64BB) .. 2
164CA A license (specify in what: TQ64CB) 3
164D A 2-year or 3-year vocational degree or diploma 4
164E A 2-year academic degree 5
164F A 4-year or 5-year college Bachelor's degree 6
164G A Master's degree or equivalent 7
164H A Ph.D. or equivalent 8
164IA An M.D., L.L.B., B.D., D D., D D.S., or equivalent (specify degree: TQ64IB) ... 9
164JA Other (specify: TQ64JB) 10

TQ65 65. **During October 1976, did you work for the school you were attending?**

(Circle one.)

Yes, working for pay 1
Yes, working off cost of tuition, housing, or meals 2
Yes, both of the above 3
No 4

SCHOOL ATTENDANCE IN OCTOBER 1975

TQ66 66. **Now please think back to Fall 1975. Were you taking classes or courses at any school during the month of October 1975?**

No .....1 *GO TO Q. 79, p. 17*
Yes, at the same school I attended in October 1976 and reported above in Q. 53 .....2 *GO TO Q. 70*
Yes, at a school I have not yet reported .....3 *CONTINUE WITH Q. 67*

67. **What is the exact name and location of the school you were attending in October 1975? (Please print and do not abbreviate.)**

School Name: TQ67A

City: TQ67B State: TQ67C

TQ68 68. **What kind of school is this?**

(Circle one.)

Vocational, trade, business or other career training school 1
Junior or community college (two-year) 2
College or university (four years or more) 3
Independent graduate or professional school (medical, dental, law, theology, etc.) 4
Other (describe: _____) 5

69. **When did you first attend this school?** TQ69A (month) TQ69B (year)

TQ70 70. **During October 1975, were you classified by this school as a full-time student?**

Yes 1
No 2
Don't know 3

TQ71 71. **During October 1975, about how many hours a week did your classes meet in the subjects or courses in which you were enrolled? Include time in lectures, shop, laboratories, etc.**

_____ hours per week

2 72. **At that time how were you classified by your school?**

(Circle one.)

Freshman (first-year undergraduate student) 1
Sophomore (second-year undergraduate student) 2
Junior (third-year undergraduate student) 3
Senior (fourth-year undergraduate student) 4
Graduate or professional student 5
Special student 6
Other classification (specify: _____) 7
My school doesn't classify students 8

73 73. **Was your field of study or training area in October 1975 the same as it was in October 1976?**

(Circle one.)

Yes .....1 *GO TO Q. 77, next page*
No, was not in school in October 1976. .....2 } *CONTINUE WITH Q. 74*
No, different from October 1976 .....3 }

74 74. **As of October 1975, what was your actual or intended field of study or training area (for example, practical nurse, machinist, beautician, civil engineering, accounting, psychology, home economics, etc.)? Please name the specific field or area:**

(Write in): _____

75 75. **Please select below the category which best describes this field or area.**

(Circle one.)

Agriculture and Home Economics 1
Business (accounting, marketing, personnel management, etc.) 2
Office and Clerical (bookkeeping, stenography, general office, etc.) 3
Computer Technology (keypunch operator, programming, computer operations, etc.) 4
Education (elementary, special, physical, etc.) 5
Engineering (civil, electrical, mechanical, etc.) 6
Mechanical and Engineering Technology (automotive mechanic, machinist, construction, drafting, electronics, etc.) 7
Humanities and Fine Arts (music, religion, English, etc.) 8
Health Services (nursing, lab technician, occupational therapy, etc.) 9
Public Services (law enforcement, food service, recreation, beautician, etc.) 10
Physical Sciences and Mathematics (physics, geology, chemistry, etc.) 11
Social Sciences (psychology, history, economics, sociology, etc.) 12
Biological Sciences (zoology, physiology, anatomy, etc.) 13
Professional Program (medicine, dentistry, law, theology, etc.) 14
OTHER field or area (specify: TQ75FS) ...15
UNDECIDED 16

76 76. **This (above) is:**

(Circle one.)

A vocational program 1
An academic program 2
A professional program 3
Other (specify: _____) 4

77. As of October 1975, what kind of certificate, license, diploma, or degree were you studying for?

(Circle as many as apply.)

TQ77A	None	1
TQ77BA	A certificate (specify in what: TQ77BB)	2
TQ77CA	A license (specify in what: TQ77CB)	3
TQ77D	A 2-year or 3-year vocational degree or diploma	4
TQ77E	A 2-year academic degree	5
TQ77F	A 4-year or 5-year college Bachelor's degree	6
TQ77G	A Master's degree or equivalent	7
TQ77H	A Ph.D. or equivalent	8
TQ77IA	An M.D., L.L.B., B.D., D.D., D.D.S., or equivalent (specify degree: TQ77IB)	9
TQ77JA	Other (specify: TQ77JB)	10

TQ78 78. During October 1975, did you work for the school you were attending?

(Circle one.)

Yes, working for pay 1
Yes, working off cost of tuition, housing, or meals 2
Yes, both of the above 3
No 4

SINCE OCTOBER 1974

TQ79 79. Has your field of study or training area changed at any time since October 1974, two years ago?

No ..... 1 *GO TO Q. 81*
Yes ..... 2 *CONTINUE WITH Q. 80*

80. Listed below are some reasons why students change fields or training areas. What were the reasons in your situation?

(Circle one number on each line.)

			My Reasons	NOT My Reasons
TQ80A	a.	Courses more difficult than I expected	1	2
TQ80B	b.	Met people with new ideas	1	2
TQ80C	c.	Poor advice on original choice	1	2
TQ80D	d.	Lack of information on jobs related to original choice	1	2
TQ80E	e.	Content of courses different from what I expected	1	2
TQ80F	f.	New information about other fields of study or training areas	1	2
TQ80G	g.	Interest aroused by courses	1	2
TQ80H	h.	More jobs available for graduates in the field I changed to	1	2
TQ80I	i.	Better jobs available for graduates in the field I changed to	1	2
TQ80J	j.	Interest aroused by job I have held	1	2
TQ80K	k.	Other (specify: _____)	1	2

TQ81 81. Have you changed schools at any time since October 1974, two years ago?

No ..... 1 *GO TO Q. 83, next page*
Yes ..... 2 *CONTINUE WITH Q. 82*

82. What were your reasons for changing schools?

(Circle one number on each line.)

		My Reasons	NOT My Reasons
82A	a. Enrolled in graduate or professional study at another school	1	2
82B	b. My interest changed, and my former school did not offer the course of study I wanted	1	2
82C	c. Wanted to attend a less expensive school	1	2
82D	d. Wanted to be at a smaller school	1	2
82E	e. Wanted to be at a larger school	1	2
82F	f. Wanted to attend school closer to home	1	2
82G	g. Wanted to attend a school farther away from home	1	2
82H	h. Wanted to attend a school that would give me better career opportunities	1	2
82I	i. Wanted to attend a more prestigious school	1	2
82J	j. Wanted to attend a school where I could maximize my intellectual and personal development	1	2
82K	k. More group or social activities of interest	1	2
82L	l. Transferred from a two-year to a four-year school to continue my education	1	2
82M	m. Family responsibilities	1	2
82N	n. Health problems or physical handicap	1	2
82Ø	o. Other (specify: _____)	1	2

2

83 83. Since October 1974, have you withdrawn from any school before you completed your studies at that school?

(Circle one.)

- No ..... 1 *GO TO Q. 85, next page*
- Yes, but I have since returned to school 2
- Yes, but I plan to return before October 1977 3
- Yes, and I do not plan to return before October 1977 4

} *CONTINUE WITH Q. 84*

84. What were your reasons for withdrawing?

(Circle one number on each line.)

		My Reasons	NOT My Reasons
84A	a. Health problems or physical handicap	1	2
84B	b. Had financial difficulties	1	2
84C	c. Was offered a good job	1	2
84D	d. Got married or planned to get married	1	2
84E	e. School work was not relevant to the real world	1	2
84F	f. Wanted to get practical experience	1	2
84G	g. Failing or not doing as well as I wanted	1	2
84H	h. Wasn't really sure what I wanted to do	1	2
84I	i. Transferred to another school	1	2
84J	j. Family responsibilities	1	2
84K	k. Other (describe: _____)	1	2

114

85. a. Estimate how well you have done in all of your coursework or programs since high school and until October 1976. Do not include grades from graduate or professional school. (Circle one number in Column A.)

b. Estimate how well you have done in your coursework or programs only in the 2-year period from October 1974 through October 1976. Do not include grades from graduate or professional school. (Circle one number in Column B.)

	TQ85A A. From High School to October 1976	TQ85B B. October 1974 - October 1976
Mostly A (3.75-4.00 grade point average)	1	1
About half A and half B (3.25-3.74 grade point average)	2	2
Mostly B (2.75-3.24 grade point average)	3	3
About half B and half C (2.25-2.74 grade point average)	4	4
Mostly C (1.75-2.24 grade point average)	5	5
About half C and half D (1.25-1.74 grade point average)	6	6
Mostly D or below (less than 1.25)	7	7
Have not taken any courses for which grades were give	8	8

TQ86 86. Considering all of the schools you have attended since high school, do ANY of these schools or programs give credits which can be used for a 4-year college Bachelor's degree?

I don't know 1
No 2
} *GO TO Q. 88*

Yes .....3 *CONTINUE WITH Q. 87* →

87. Since leaving high school, about how many credits had you earned by October 1976? (Write in.)

TQ87A _____ Number of quarter hours
TQ87B _____ Number of semester hours
TQ87C _____ Number of other type of credits (specify type: _____)

SCHOOL FINANCES FROM FALL 1974 THROUGH SUMMER 1976

The following questions ask about your school finances for the two time periods of (a) Fall 1974 through Summer 1975 and (b) Fall 1975 through Summer 1976. Please make sure you answer each question for both time periods. If you are unsure about the actual dollar amount for a particular item, give your best estimate.

88. Were you in school at any time during either of the twelve-month periods from (a) Fall 1974 through Summer 1975 or (b) Fall 1975 through Summer 1976?

	(a) Fall 1974 - Summer 1975		(b) Fall 1975 - Summer 1976	
TQ88AA	Yes .....1 No 2	How many months? TQ88AB	Yes .....1 TQ88BA No 2	How many months? TQ88BB

89. Considering the two time periods of (a) Fall 1974 through Summer 1975 and (b) Fall 1975 through Summer 1976, what is your estimate of how much it cost for you to live and go to school, regardless of who paid? Estimate the amounts and record them below. Enter a zero, "0," where you had no expenses. Do not include costs after Summer 1976. Record your expenses for the time you were in school only.

	(a) Fall 1974 - Summer 1975	(b) Fall 1975 - Summer 1976
Tuition and fees	$ TQ89AA	$ TQ89AB
Books and supplies	$ TQ89BA	$ TQ89BB
Transportation to and from class from where I lived while attending school	$ TQ89CA	$ TQ89CB
Other school-related expenses	$ TQ89DA	$ TQ89DB
Housing and meals while enrolled in school	$ TQ89EA	$ TQ89EB
All other expenses while enrolled in school: medical, dental expenses, debt payments, insurance, taxes, child care, etc.	$ TQ89FA * TQ89GAA,GAB	$ TQ89FB * TQ89GBA,GBB
HOW MUCH MONEY IS THIS IN TOTAL?	$ TQ89HA	$ TQ89HB

SCHOLARSHIPS, FELLOWSHIPS, GRANTS, AND BENEFITS

90 90. Considering the two time periods of (a) Fall 1974 through Summer 1975 and (b) Fall 1975 through Summer 1976, did you receive any kind of scholarship, fellowship, grant, or benefits to go to school?

- No ..... 1 — *GO TO Q. 92*
- Yes, Fall 1974 - Summer 1975 2
- Yes, Fall 1975 - Summer 1976 3
- Yes, both of these periods 4

CONTINUE WITH Q. 91

91. Estimate the amounts for each scholarship, fellowship, grant, or benefit you received, and record them below. Enter a zero, "0," where you received no financial assistance. Do not include loans.

	(a) Fall 1974 - Summer 1975	(b) Fall 1975 - Summer 1976
a. Basic Educational Opportunity Grant	$ TQ91AA	$ TQ91AB
b. Supplemental Educational Opportunity Grant	$ TQ91BA	$ TQ91BB
c. College scholarship or grant from college funds	$ TQ91CA	$ TQ91CB
d. ROTC scholarship or stipend	$ TQ91DA	$ TQ91DB
e. Nursing Scholarship Program	$ TQ91EA	$ TQ91EB
f. Social Security Benefits (for students 18-22 who are children of disabled or deceased parents)	$ TQ91FA	$ TQ91FB
g. Veterans Administration War Orphans or Survivors Benefits Program	$ TQ91GA	$ TQ91GB
h. Veterans Administration Direct Benefits (GI Bill)	$ TQ91HA	$ TQ91HB
i. State scholarship	$ TQ91IA	$ TQ91IB
j. Other scholarship or grant (write in: _____)	$ TQ91JA	$ TQ91JB
TOTAL DOLLAR VALUE	$ TQ91KA	$ TQ91KB

LOANS

Q92 92. Considering the same two periods from (a) Fall 1974 through Summer 1975 and (b) Fall 1975 through Summer 1976, did you receive a loan to go to school?

- No ..... 1 — *GO TO Q. 94, next page*
- Yes, Fall 1974 - Summer 1975 2
- Yes, Fall 1975 - Summer 1976 3
- Yes, both of these periods 4

CONTINUE WITH Q. 93

e manual for coding instructions.

93. Estimate the amounts for each loan you received and record them below. Enter a zero, "0," where you received no loan.

	(a) Fall 1974-Summer 1975	(b) Fall 1975-Summer 1976
Federal Guaranteed Student Loan	$ TQ93AA	$ TQ93AB
State loan	$ TQ93BA	$ TQ93BB
Regular bank loan	$ TQ93CA	$ TQ93CB
National Defense (Direct) Student Loan	$ TQ93DA	$ TQ93DB
Nursing Student Loan	$ TQ93EA	$ TQ93EB
School or college loan	$ TQ93FA	$ TQ93FB
Relatives or friends	$ TQ93GA	$ TQ93GB
Other loan (write in: _____)	$ TQ93HA	$ TQ93HB
TOTAL DOLLAR VALUE	$ TQ93IA	$ TQ93IB

FINANCIAL ASSISTANCE FROM RELATIVES OR FRIENDS

TQ94 94. Considering the two time periods of (a) Fall 1974 through Summer 1975 and (b) Fall 1975 through Summer 1976, did you receive financial assistance (not a loan) from any relatives or friends to go to school?

- No .....1 *GO TO Q. 96*
- Yes, Fall 1974 - Summer 1975 2
- Yes, Fall 1975 - Summer 1976 3
- Yes, both of these periods 4

} *CONTINUE WITH Q. 95*

95. Estimate the amounts you received and record them below. Enter a zero, "0," where you received no financial assistance.

	(a) Fall 1974-Summer 1975	(b) Fall 1975-Summer 1976
Parents	$ TQ95AA	$ TQ95AB
Husband or wife	$ TQ95BA	$ TQ95BB
Other family or friends	$ TQ95CA	$ TQ95CB
TOTAL DOLLAR VALUE	$ TQ95DA	$ TQ95DB

MONEY YOU HAD SAVED OR EARNED

TQ96 96. Considering the same two periods from (a) Fall 1974 through Summer 1975 and (b) Fall 1975 through Summer 1976, did you pay any of the costs to go to school from money you had saved or earned?

- No .....1 *GO TO Q. 98. next page*
- Yes, Fall 1974 - Summer 1975 2
- Yes, Fall 1975 - Summer 1976 3
- Yes, both of these periods 4

} *CONTINUE WITH Q. 97*

97. Estimate the amounts and record below. Enter a zero "0," where you received no money.

	(a) Fall 1974-Summer 1975	(b) Fall 1975-Summer 1976
Own savings or summer earnings	$ TQ97AA	$ TQ97AB
College work-study or cooperative education program	$ TQ97BA	$ TQ97BB
Teaching or research assistantship	$ TQ97CA	$ TQ97CB
Other earnings while taking courses	$ TQ97DA	$ TQ97DB
TOTAL DOLLAR VALUE	$ TQ97EA	$ TQ97EB

SCHOOL FINANCES FROM FALL 1976 THROUGH SUMMER 1977

98 98. **Are you or will you be in school at any time from Fall 1976 through Summer 1977?**

No.....1 } *GO TO Q. 101*
Don't know .....2 }
Yes .....3 *CONTINUE WITH Q. 99*

99. **What is your estimate of how much it will cost for you to live and go to school this year, regardless of who pays? Estimate your expenses and record them below. Enter a zero, "0," where you expect no expenses.**

99A	Tuition and fees	$ _____
99B	Books and supplies	$ _____
99C	Transportation to and from class from where I live while attending school.....	$ _____
99D	Other school-related expenses.....	$ _____
99E	Housing and meals while enrolled in school	$ _____
99F	All other expenses while enrolled in school: medical, dental expenses, debt payments, insurance, taxes, child care etc.....	$ _____
99GA,GB*		
99H	HOW MUCH MONEY IS THIS IN TOTAL?	$ _____

100. **How are you meeting (or planning to meet) these expenses? Estimate the amounts you expect to receive from each source and record them below. Enter a zero, "0," where you expect no money.**

		Amount will receive from each source
100A	Grant.....	$ _____
100B	Fellowship	$ _____
100C	Scholarship.....	$ _____
100D	Loan	$ _____
100E	Teaching or research assistantship	$ _____
100F	Job other than assistantship	$ _____
100G	Spouse's income	$ _____
100H	Savings.....	$ _____
100I	Parents.....	$ _____
100J	Other relatives or friends	$ _____
100K	Other (specify: _____).....	$ _____

GRADUATE OR PROFESSIONAL SCHOOL

101 101. **Have you received a Bachelor's degree from a four-year college or university?**

No.....1 *GO TO Q. 108, p. 24*
Yes .....2 *CONTINUE WITH Q. 102*

102 102. **Did you formally apply for admission (fill out a form and send it in) to any graduate or professional school at any time before October 1976?**

No.....1 *GO TO Q. 104, next page*
Yes .....2 *CONTINUE WITH Q. 103*

See manual for coding instructions.

103. **Please list below the graduate institutions to which you applied, the city and state in which the institutions are located, and the department or program (e.g., law school, public health, journalism, psychology).**

At the right circle the number for yes or no if you (a) were accepted; (b) applied for financial assistance such as a grant, fellowship, loan, teaching or research assistantship, etc.; (c) were offered financial assistance, and (d) enrolled.

	(a) Was Accepted	(b) Applied for Financial Assistance	(c) Was Offered Financial Assistance	(d) Enrolled
First Choice				
School: TQ103ASC	TQ103AA	TQ103AB	TQ103AC	TQ103AD
City: TQ103ACT State: TQ103AST	Yes....1	Yes....1	Yes....1	Yes....1
Department or program: TQ103AFS	No.....2	No.....2	No.....2	No.....2
Second Choice				
School: TQ103BSC	TQ103BA	TQ103BB	TQ103BC	TQ103BD
City: TQ103BCT State: TQ103BST	Yes....1	Yes....1	Yes....1	Yes....1
Department or program: TQ103BFS	No 2	No.....2	No.....2	No.... 2
Third Choice				
School: TQ103CSC	TQ103CA	TQ103CB	TQ103CC	TQ103CD
City: TQ103CCT State: TQ103CST	Yes....1	Yes....1	Yes....1	Yes....1
Department or program: TQ103CFS	No. ..2	No.....2	No.....2	No.... 2

TQ104 104. **Circle the category that describes your present status with respect to graduate or professional school.**

(Circle one.)

I **have attended** graduate or professional school but **am not presently attending** 1
I **am presently attending** graduate or professional school .....2 } *GO TO Q. 106. next page*

I **have never attended** graduate or professional school .....3 *CONTINUE WITH Q. 105*

105. **Which of the following factors are important reasons for your not attending graduate or professional school?** *(After you have answered this question. go to Q. 108. next page.)*

(Circle as many as apply.)

TQ105A a. I have no interest in graduate or professional education 1
TQ105B b. I have family responsibilities that require my presence at home 2
TQ105C c. I was refused a loan 3
TQ105D d. I cannot financially afford to attend graduate school at the present time 4
TQ105E e. I can earn a satisfactory income without attending graduate school..... 5
TQ105F f. I want additional work experience before applying to graduate school..... 6
TQ105G g. My career goals are very uncertain 7
TQ105H h. I do not need an advanced degree to succeed in the field I am now in (or want to enter) 8
TQ105I i. I'm tired of school 9
TQ1C5J j. I was not accepted at the institution of my choice 10
TQ105K k. Health problems or physical handicap 11
TQ105L l. Other (specify: _____)....12

} *GO TO Q. 108 next page*

106. How important was each of the following reasons in your deciding to attend graduate or professional school?

(Circle one number on each line.)

		Determining Factor	Important	Not Important	Did NOT Consider
106A	Obtaining credentials for a specific career	1	2	3	4
106B	No satisfactory jobs available	1	2	3	4
106C	Better salary	1	2	3	4
106D	Enjoy school	1	2	3	4
106E	Interest in subject matter	1	2	3	4
106F	Better job opportunities	1	2	3	4
106G	Other (specify: _____)	1	2	3	4

107. How important was each of the following reasons in your choosing the institution in which you are (were) enrolled for your graduate or professional study?

(Circle one number on each line.)

		Determining Factor	Important	Not Important	Did NOT Consider
107A	a. Cost of attending	1	2	3	4
107B	b. Availability of financial aid	1	2	3	4
107C	c. Recommendation of undergraduate professor	1	2	3	4
107D	d. Presence of a particular professor at the institution	1	2	3	4
107E	e. Quality of a particular department	1	2	3	4
107F	f. Reputation of the institution	1	2	3	4
107G	g. Location	1	2	3	4
107H	h. Library facilities	1	2	3	4
107I	i. Proximity to spouse's school/work	1	2	3	4
107J	j. Other (specify: _____)	1	2	3	4

OTHER TRAINING

108 108. Since October 1974, have you participated in any program such as on-the-job training, registered apprenticeships, manpower training programs, personal enrichment, or correspondence courses? Do not include regular school and college programs.

No .....1 *GO TO Q. 116, next page*
Yes .....2 *CONTINUE WITH Q. 109*

109. What type of training program(s) or course(s) have you participated in?

(Circle as many as apply.)

109A	a.	An Armed Forces training program 1
109B	b.	On-the-job training (a program of instruction during normal working hours) 2
109C	c.	Employer-provided program of instruction other than on-the-job training 3
109D	d.	Formal Registered Apprenticeship (your state or labor union) 4
109E	e.	Manpower Development and Training (MDTA) 5
109F	f.	Work Incentive (WIN) 6
109G	g.	Neighborhood Youth Corps (NYC) 7
109H	h.	Comprehensive Employment and Training Act (CETA) 8
109I	i.	Other manpower program (specify _____) 9
109J	j.	Correspondence course(s) 10
109K	k.	Non-credit courses for personal enrichment 11
109L	l.	Other (specify: _____) 12

CONTINUE

TQ110 110. **Were you being trained for some type of work?**

No .....1 *GO TO Q. 112*
Yes.....2 *CONTINUE WITH Q. 111*

TQ111 111. **What type of work were you being trained for or learning about? If you have participated in more than one program, answer for the one in which you spent the most time. (Examples: plumbing, typing, auto mechanic work, photography, sales, etc.)**

(Write in): _____

TQ112 112. **How long is (or was) this program scheduled to last?**

(Circle one.)

Less than one month 1
One to five months 2
Six to eleven months 3
One year or more 4

TQ113 113. **Have you completed this program?**

(Circle one.)

Yes 1
No, left without completing 2
No, still enrolled 3

TQ114 114. **Have you used this training on any job?**

Yes 1
No 2

TQ115 115. **Which one of the following statements best describes the assistance you received (are receiving) from the program or training center in finding a job?**

(Circle one.)

DOES NOT APPLY TO ME since my training was in the military, on-the-job, or for personal enrichment 1
I did not want or did not need help from the center in finding a job 2
I wanted and needed help but did not receive any from the center 3
The center provided information on job openings in my field 4
The center put me directly in touch with possible employers or arranged a job for me 5

TQ116 116. **Have you ever tried to find work on a job where you might use what you learned from any school, college, or training program you attended since October 1974?**

No, because I have NOT attended any school or college since October 1974 1
No, although I HAVE attended a school or college since October 1974 2
SKIP TO SECTION D, next page
Yes.....3 *CONTINUE WITH Q. 117*

TQ117 117. **Did you find work for which you could use what you learned?**

(Circle one.)

Yes, in the locality where I received my training 1
Yes, somewhere else 2
Yes, both of the above.....3
No 4

SECTION D: MILITARY SERVICE

118 118. Since October 1974, have you served in the Armed Forces, or a Reserve or National Guard Unit?
(Circle one.)

No ..... 1 } SKIP TO SECTION E. next page
Yes, National Guard or Reserves but not active duty ..... 2 }
Yes, active duty ..... 3 CONTINUE WITH Q. 119

119 119. In which branch of the Armed Forces did you serve? (Write in): _____

120. When did you begin active duty? TQ120A (month) TQ120B (year)

121 121. Have you received (or are you receiving) four or more weeks of specialized schooling while in the Armed Forces?

No ..... 1 GO TO Q. 123
Yes ..... 2 CONTINUE WITH Q. 122

122 122. What is the name of the specialized schooling program in which you spent the longest period of time? (Please print and do not abbreviate.)

Name of program: _____

TQ124

123 123. Specify your current primary military specialty code (Army-MOS, Air Force-AFSC, Marines-MOS, Navy-NEC). (Please print and use standard abbreviations.)
Specialty Code: _____

124. What is the highest pay grade you have held?
Pay grade: _____

125. Have you taken any courses while in the Armed Forces that:
(Circle one number on each line.)

		Yes	No
125A	Prepared you for the high school equivalency test?	1	2
125B	Prepared you for equivalency tests that can be taken for college credit?	1	2
125C	Were college-sponsored courses which gave college credits?	1	2

126. Are your currently on active duty?

TQ126A No (Date left: TQ126B month TQ126C year) ..... 1 SKIP TO SECTION E. next page
Yes ..... 2 CONTINUE WITH Q. 127

127 127. How long do you expect to be on active duty in the Armed Forces?
(Circle one.)

For a two-year tour of duty only 1
For a three- or four-year tour of duty 2
For more than one enlistment, but less than a full career 3
For a full career (20 years minimum) 4
Have not decided 5

128. What do you plan to do when you get out of the Armed Forces?
(Circle one number on each line.)

		My Plans	NOT My Plans
128A	Full-time or part-time work	1	2
128B	Graduate or professional school, either full-time or part-time	1	2
128C	College, either full-time or part-time	1	2
128D	Technical, vocational, or business or career training school, either full-time or part-time	1	2
128E	Registered apprenticeship or on-the-job training program	1	2
128F	Retire	1	2
128G	Undecided	1	2
128H	Other (specify: _____)	1	2

START

SECTION E: FAMILY STATUS

TQ129 **129. What was your marital status, as of the first week of October 1976?**

(Circle one.)

Never married, but plan to be married within the next 12 months 1	GO TO Q. 137, next page
Never married, and don't plan to be married within the next 12 months 2	
Divorced, widowed, separated 3	CONTINUE WITH Q. 130
Married 4	

130. What was the date of your marriage?

TQ130A (month) TQ130B (year)

131. As of the first week of October 1976, what was your husband or wife doing?

TQ131BOX *(If you were not married in the first week of October 1976, check here ☐ and go to Q. 136, next page.)*

(Circle as many as apply.)

TQ131A	Working for pay at a full-time or part-time job 1
TQ131B	Enrolled in graduate or professional school 2
TQ131C	Taking academic courses at a two- or four-year college 3
TQ131D	Taking vocational or technical courses at any kind of school or college (for example, vocational, trade, business, or other career training school) 4
TQ131E	On active duty in the Armed Forces (or service academy) 5
TQ131F	Homemaker 6
TQ131G	Temporary layoff from work, looking for work, or waiting to report to work 7
TQ131H	Other (describe: _____) 8

132. Please describe below the job your husband or wife held during the first week of October 1976.

TQ132BOX *(If your spouse was not working, check here ☐ and go to Q. 135, next page.)*

TQ132A a. For whom did he/she work? (Name of company, business organization, or other employer)
(Write in): _____

TQ132B b. What kind of business or industry was this? (For example, retail shoe store, restaurant, etc.)
(Write in): _____

TQ132C c. What kind of job or occupation did he, she have in this business or industry? (For example, salesperson, waitress, secretary, etc.)
(Write in): _____

TQ132D d. What were his/her most frequent activities or duties on this job? (For example, selling shoes, waiting on tables, typing and filing, etc.)
(Write in): _____

TQ132E e. Was he/she:

(Circle one.)

An employee of a PRIVATE company, bank, business, school, or individual working for wages, salary, or commissions?	1
A GOVERNMENT employee (Federal, State, county, or local institution or school)?	2
Self-employed in his/her OWN business, professional practice, or farm?	3
Working WITHOUT PAY in family business or farm?	4

Q133 133. **How many hours did he/she usually work at this job in an average week?**

_____ Hours per week

Q134 134. **In an average week, approximately how much did he/she earn at this job? (Report his/her gross earnings before deductions. If not paid by the week, please estimate.)**

$_____ per week
(Earnings before deductions)

Q135 135. **As of October 1976, what was the highest level of education that your husband or wife had attained?**

(Circle one.)

Some high school or less 1
Finished high school 2
Vocational trade or business school ..... Less than two years ..... 3; Two years or more 4
College program ..... Less than two years of college ..... 5; Two or more years of college (including two-year degree) ..... 6; Finished college (four- or five-year degree) ..... 7; Master's degree or equivalent ..... 8; Ph.D., or advanced professional degree 9

136. **Now please think back a year to Fall 1975. What was your husband or wife doing in October 1975?**

Q136BOX *(If you were not married in October 1975, check here ☐ and continue with Q. 137.)*

(Circle as many as apply.)

Q136A Working for pay at a full-time or part-time job 1
Q136B Enrolled in graduate or professional school 2
Q136C Taking academic courses at a two- or four-year college 3
Q136D Taking vocational or technical courses at any kind of school or college (for example, vocational, trade, business, or other career training school) 4
Q136E On active duty in the Armed Forces (or service academy) 5
Q136F Homemaker 6
Q136G Temporary layoff from work, looking for work, or waiting to report to work 7
Q136H Other (describe: _____) 8

Q137 137. **Are you a twin?**

Yes 1
No 2

TQ138A 138. a. How many children altogether do you eventually expect to have?

(Circle one.)

0.....1.....2.....3.....4.....5.....6.....7.....8 or more

TQ138B b. As of the first week of October 1976, how many children did you have?

(Circle one.)

0.....1.....2.....3.....4.....5.....6 or more

TQ138C c. When do you expect to have your first (next) child?

(Circle one.)

Don't expect to have a (another) child.....1
Within the next year.....2
Between one and two years from now.....3
Between two and three years from now.....4
Between three and five years from now.....5
More than five years from now.....6
Don't know.....7

TQ139 139. Not including yourself, how many persons were dependent upon you for more than one-half of their financial support as of the first week of October 1976?

(Circle one.)

0.....1.....2.....3.....4.....5.....6 or more

140. As of the first week of October 1976, were you dependent upon your parents, spouse, or any other relatives or friends for more than one-half of your financial support?

(Circle one number on each line.)

		Yes	No
TQ140A	Parents	1	2
TQ140B	Spouse	1	2
TQ140C	Other relatives or friends	1	2

141. What is the best estimate of your income before taxes for (a) ALL OF 1975 and for (b) ALL OF 1976? If married, include your spouse's income in the total. Do not include loans. Please make a dollar amount entry on each line. If you did not receive any income from a source, enter a zero, "0."

	(a) Amount Received 1975	(b) Amount Will Receive 1976
Your own wages, salaries, commissions, or net income from a business or farm	$ TQ141AA	$ TQ141AB
Your spouse's (husband or wife) wages, salaries, commissions, or net income from a business or farm	$ TQ141BA	$ TQ141BB
Public assistance or welfare (include spouse's)	$ TQ141CA	$ TQ141CB
Unemployment compensation (include spouse's)	$ TQ141DA	$ TQ141DB
All other income you and your spouse received (include interest, dividends, rental property income, gifts, scholarships, fellowships, etc.)	$ TQ141EA	$ TQ141EB
TOTAL INCOME FOR YOU AND YOUR SPOUSE	$ TQ141FA	$ TQ141FB

142. As of the first week of October 1976, how much money did you owe for:

(Circle one number on each line.)

		None	Less than $100	$100 to $499	$500 to $999	$1000 to $1999	$2000 to $4999	$5000 to $9999	$10,000 or More
L42A	Education or training	0	1	2	3	4	5	6	7
L42B	Mortgage on house or mobile home	0	1	2	3	4	5	6	7
L42C	Other debts (car, rent, appliances, medical bills, and so on)	0	1	2	3	4	5	6	7

143. As of the first week of October 1976, how much money had you saved and planned to use for:

(Circle one number on each line.)

		None	Less than $100	$100 to $499	$500 to $999	$1000 to $1999	$2000 or More
L43A	Education or training	0	1	2	3	4	5
L43B	Other plans (or general savings)	0	1	2	3	4	5

L44 144. Do you owe any money for an education or training loan for which your repayment schedule has begun?

No ....1 *SKIP TO SECTION F, next page*
Yes ....2 *CONTINUE WITH Q. 145*

145. When was your first payment due?

TQ145A (month) TQ145B (year)

146 146. Are you having or have you had any difficulty in meeting payments?

No 1
Yes ....2 (explain why: _____)

SECTION F: EXPERIENCES AND OPINIONS

START

147. To what extent have you voluntarily participated in the following groups during the two-year period from October 1974 through October 1976? (By voluntarily, we mean you are not an employee of the group; by active participant, we mean that you attend the meetings or events; by member only, we mean that you are on a mailing or telephone list so that you are kept informed of meetings and events.)

(Circle one number on each line.)

		Active Participant	Member Only	Not At All
TQ147A	a. Youth organizations—such as Little League coach. scouting etc.	1	2	3
TQ147B	b. Union. farm. trade or professional association	1	2	3
TQ147C	c. Political clubs or organizations	1	2	3
TQ147D	d. Church or church-related activities (not counting worship services)	1	2	3
TQ147E	e. Community centers. neighborhood improvement. or social-action associations or groups	1	2	3
TQ147F	f. Organized volunteer work—such as in a hospital	1	2	3
TQ147G	g. A social. hobby. garden. or card playing group	1	2	3
TQ147H	h. Sport teams or sport clubs	1	2	3
TQ147I	i. A literary. art, discussion. music. or study group	1	2	3
TQ147J	j. Educational organizations—such as PTA or an academic group	1	2	3
TQ147K	k. Service organizations—such as Rotary. Junior Chamber of Commerce. Veterans. etc.	1	2	3
TQ147L	l. A student government. newspaper. journal. or annual staff	1	2	3
TQ147M	m. Another voluntary group in which I participate	1	2	3

148. How do you feel about each of the following statements?

(Circle one number on each line.)

		Agree Strongly	Agree	Disagree	Disagree Strongly	No Opinion
TQ148A	I take a positive attitude toward myself	1	2	3	4	5
TQ148B	Good luck is more important than hard work for success	1	2	3	4	5
TQ148C	I feel I am a person of worth. on an equal plane with others	1	2	3	4	5
TQ148D	I am able to do things as well as most other people	1	2	3	4	5
TQ148E	Every time I try to get ahead. something or somebody stops me	1	2	3	4	5
TQ148F	Planning only makes a person unhappy since plans hardly ever work out anyway	1	2	3	4	5
TQ148G	People who accept their condition in life are happier than those who try to change things	1	2	3	4	5
TQ148H	On the whole. I'm satisfied with myself	1	2	3	4	5

149. Have you ever been given a special advantage or treated unfairly because of your sex (male or female) in any of the following situations?

	Given Special Advantage (Circle as many as apply.)		Treated Unfairly (Circle as many as apply.)	
Getting a good education	1	TQ149AA	1	TQ149AB
Getting a job, promotion, or other work benefits	2	TQ149BA	2	TQ149BB
Getting a house or apartment	3	TQ149CA	3	TQ149CB
None of these	4	TQ149DA	4	TQ149DB

If so, please describe: TQ149E _____

150. How do you feel about each of the following statements?

(Circle one number on each line.)

		Agree Strongly	Agree	Disagree	Disagree Strongly
150A	a. A working mother of pre-school children can be just as good a mother as the woman who doesn't work	1	2	3	4
150B	b. It is usually better for everyone involved if the man is the achiever outside the home and the woman takes care of the home and family	1	2	3	4
150C	c. Young men should be encouraged to take jobs that are usually filled by women (nursing, secretarial work, etc.)	1	2	3	4
150D	d. Most women are just not interested in having big and important jobs	1	2	3	4
150E	e. Many qualified women can't get good jobs: men with the same skills have much less trouble	1	2	3	4
150F	f. Most women are happiest when they are making a home and caring for children	1	2	3	4
150G	g. High school counselors should urge young women to train for jobs which are now held mainly by men	1	2	3	4
150H	h. It is more important for a wife to help her husband than to have a career herself	1	2	3	4
150I	i. Schools teach women to want the less important jobs	1	2	3	4
150J	j. Men should be given first chance at most jobs because they have the primary responsibility for providing for a family	1	2	3	4

151. How important is each of the following to you in your life?

(Circle one number on each line.)

		Very Important	Somewhat Important	Not Important
151A	a. Being successful in my line of work	1	2	3
151B	b. Finding the right person to marry and having a happy family life	1	2	3
151C	c. Having lots of money	1	2	3
151D	d. Having strong friendships	1	2	3
151E	e. Being able to find steady work	1	2	3
151F	f. Being a leader in the community	1	2	3
151G	g. Being able to give my children better opportunities than I've had	1	2	3
151H	h. Living close to parents and relatives	1	2	3
151I	i. Getting away from this area of the country	1	2	3
151J	j. Working to correct social and economic inequalities	1	2	3
151K	k. Having leisure time to enjoy my own interests	1	2	3
151L	l. Having a good education	1	2	3

152. **How important is each of the following factors in determining the kind of work you plan to be doing for most of your life?**

(Circle one number on each line.)

		Very Important	Somewhat Important	Not Important
TQ152A	a. Previous work experience in the area	1	2	3
TQ152B	b. Relative or friend in the same line of work	1	2	3
TQ152C	c. Job openings available in the occupation	1	2	3
TQ152D	d. Work matches a hobby interest of mine	1	2	3
TQ152E	e. Good income to start or within a few years	1	2	3
TQ152F	f. Job security and permanence	1	2	3
TQ152G	g. Work that seems important and interesting to me	1	2	3
TQ152H	h. Freedom to make my own decisions	1	2	3
TQ152I	i. Opportunity for promotion and advancement in the long run	1	2	3
TQ152J	j. Meeting and working with sociable, friendly people	1	2	3

153. **The following questions ask about your political participation. Considering the period from October 1974 to October 1976,**

(Circle one number on each line.)

		Frequently	Sometimes	Never
TQ153A	When you talked with your friends, did you ever talk about public problems—that is, what's happening in the country or in your community?	1	2	3
	Did you ever talk about public problems with any of the following people?			
TQ153B1	Your family	1	2	3
TQ153B2	People where you work	1	2	3
TQ153B3	Community leaders, such as club or church leaders	1	2	3
TQ153C	Did you ever talk about public problems with elected government officials or people in politics, such as Democratic or Republican leaders?	1	2	3
TQ153D	Did you ever talk to people to try to get them to vote for or against a candidate?	1	2	3
TQ153E	Did you ever give any money or buy tickets to help someone who was trying to win an election?	1	2	3
TQ153F	Did you ever go to any political meetings, rallies, barbecues, fish fries, or things like that in connection with an election?	1	2	3
TQ153G	Did you ever do any work to help a candidate in his campaign?	1	2	3
TQ153H	Did you ever hold an office in a political party or get elected to a government job?	1	2	3

TQ154 154. **Are you registered to vote?**

Yes 1
No 2

TQ155 155. **Before October 1976, did you ever vote in a local, state, or national election?**

Yes 1
No 2

156. Have you ever been given a special advantage or treated unfairly because of your race in any of the following situations?

	Given Special Advantage (Circle as many as apply.)		Treated Unfairly (Circle as many as apply.)	
Getting a good education	1	TQ156AA	1	TQ156AB
Getting a job, promotion or other work benefits	2	TQ156BA	2	TQ156BB
Getting a house or apartment	3	TQ156CA	3	TQ156CB
None of these	4	TQ156DA	4	TQ156DB

If so, please describe: TQ156E _____

157. What are your feelings about the high school you graduated from?

(Circle one number on each line.)

		Agree Strongly	Agree Somewhat	Disagree Somewhat	Disagree Strongly	Does not Apply
57A	School should have placed more emphasis on basic academic subjects (math, science, English, etc.)	1	2	3	4	5
57B	School did not offer enough practical work experience	1	2	3	4	5
57C	School should have placed more emphasis on vocational and technical programs	1	2	3	4	5
57D	School provided me with counseling that helped me find employment	1	2	3	4	5
57E	School should have given more attention to my needs as an individual	1	2	3	4	5
57F	School provided me with counseling that helped me continue my education	1	2	3	4	5
57G	Other comments about your high school _____					

158. The information you have given us in this questionnaire lets us know what you have been doing during the past two years, particularly in October 1975 and October 1976. This question asks about other time periods, so that we will be sure to have a complete picture of what you've been doing since high school.

Please read through all nine activities listed below, then for EACH time period circle the number for EACH activity that you were doing at that time.

Circle all that apply for EACH column.

		Oct. 72	Oct. 73	Oct. 74	What are you doing now?	What do you expect to be doing in Oct. 1977?
158AA–AE	Working for pay at a full-time job	1	1	1	1	1
158BA–BE	Working for pay at a part-time job	2	2	2	2	2
158CA–CE	Enrolled in graduate or professional school	3	3	3	3	3
158DA–DE	Taking academic courses at a two-year or four-year college	4	4	4	4	4
158EA–EE	Taking vocational or technical courses	5	5	5	5	5
158FA–FE	On active duty in the Armed Forces (or service academy)	6	6	6	6	6
158GA–GE	Homemaker	7	7	7	7	7
158HA–HE	Temporary layoff from work, looking for work, or waiting to report to work	8	8	8	8	8
158IA–IE	Other	9	9	9	9	9

Make sure you have circled at least one number in each column.

SECTION G: BACKGROUND INFORMATION

Please PRINT your name, address, and the telephone number where you can most usually be reached during the coming year.

YOUR NAME:	TELEPHONE	
ADDRESS:	AREA CODE	NUMBER
CITY: STATE:	ZIP:	

Please PRINT the name, address and telephone number of your parents.

YOUR PARENTS' NAME:	TELEPHONE	
ADDRESS:	AREA CODE	NUMBER
CITY: STATE:	ZIP:	

Please PRINT the names and addresses of two other people who will know where to get in touch with you during the coming year. (List no more than one person who now lives with you.)

NAME:	TELEPHONE	
ADDRESS:	AREA CODE	NUMBER
CITY: STATE:	ZIP:	

NAME:	TELEPHONE	
ADDRESS:	AREA CODE	NUMBER
CITY: STATE:	ZIP:	

Please PRINT your spouse's full name (if you are married).

SPOUSE'S FULL NAME: _____

Please give the following information about yourself.

(a) Date of birth _____ (month) _____ (day) _____ (year)

(b) Sex: (Circle one.) Male.....1
Female.....2

(c) Driver's License No. _____ State _____

(d) When did you complete this questionnaire? _____(month) _____(day) _____(year)

THANK YOU FOR YOUR COOPERATION

THIS INFORMATION WILL BE KEPT IN STRICT CONFIDENCE AND WILL BE USED ONLY FOR FUTURE FOLLOW-UPS IN THE NATIONAL LONGITUDINAL STUDY OF THE HIGH SCHOOL CLASS OF 1972

Appendix D

USE OF THE BALANCED REPEATED REPLICATION METHOD TO COMPUTE THE VARIANCE OF IMPUTATION-BASED STATISTICS

Appendix D

USE OF THE BALANCED REPEATED REPLICATION METHOD TO COMPUTE THE VARIANCE OF IMPUTATION-BASED STATISTICS

The balanced repeated replication (BRR) method is a device for estimating the precision of estimates which come from surveys with complex sample designs. In this methodological study, BRR was used to estimate the variance of survey estimates when missing values in the data set were replaced using an imputation procedure. This section discusses the statistical theory underlying the BRR method of estimating variances and explains why applying the imputation procedure to the individual half samples before computing the half-sample estimates results in a variance estimate that accounts for the added variation induced by the imputation procedure. The actual implementation of BRR in this investigation is also discussed.

The balanced repeated replication (or balanced half-sample pseudoreplication as it is sometimes called) was introduced by McCarthy (1966) as a method for estimating the variance of survey estimates, including the more complex statistics such as ratio estimates and regression coefficients for which analytical expressions for the variance are not readily available in the literature. The BRR method was specifically developed for the common survey design of two replicates per strata. In this situation, a total of 2^N half samples may be formed with each half sample containing one replicate from each stratum where N is the number of strata. For linear estimators, it has been demonstrated that if K half-samples are independently selected from the entire set of 2^N possible half-samples, then the average squared deviation of the half sample estimates from the full sample estimate is equal in expectation to the usual variance estimate of the full sample statistic (McCarthy, 1966). Thus the variance of the full sample statistic $\hat{\mu}_F$ may be estimated using the half-sample estimates ($\hat{\mu}_{Hi}$) by

$$\text{Var}(\hat{\mu}_F) = \sum_{i=1}^{K} (\hat{\mu}_{Hi} - \hat{\mu}_F)^2 / K \quad . \qquad \text{(D.1)}$$

When all 2^N possible half-samples are used, this estimate of the variance will be equal to the usual full sample estimate of the variance. The reason for this is that the fluctuations among half-sample variance estimates arises from between-stratum contributions to the estimates which are cancelled out when

all 2^N possible half samples are used. McCarthy (1966) demonstrates that one may also eliminate this between strata contribution to the variance by constructing a balanced set of half-samples using orthogonal matrices such as those of Plackett and Burman (1946). The number of half-samples needed to achieve this balance will be a multiple of four and greater than or equal to the number of strata. When the sample design is based on a large number of strata (e.g., the sample design for NLS has 608 strata), it is not economically feasible to use the large number of half samples that would be required (at least 608 for NLS). In this situation, it is possible to construct a set of K partially balanced half samples that will yield a more precise estimate of the variance than would have been obtained had K independently selected half-samples been utilized (McCarthy, 1966).

It should be emphasized that in using the BRR technique the average of the half sample estimates will be equal to the full sample estimate when a linear statistic is being computed. Similarly, the BRR estimate of the variance of a linear statistic will be equal to the usual variance estimate. However, for nonlinear statistics such as ratio estimates of means and proportions which are the statistics being computed in this study, the average of the balanced half sample means is not strictly equal to the full sample estimate so that no general claims of unbiasedness can be made for the BRR variance estimate. However, based upon the results of simulation studies, the BRR technique appears to yield relatively unbiased estimates of the variance which lead to robust statistical inference (Frankel, 1971).

1. Use of BRR to Estimate the Variance of Imputation-Based Statistics

The balanced repeated replication estimators used in this study to approximate the sampling variance of imputation-based means and proportions have the same formal justification that would apply if no imputation were involved. When the primary sampling units (PSUs) are drawn from primary strata in pairs and with replacement, statistics based entirely on a half-sample composed of one PSU from each stratum are independent of the companion statistics based on the complementary half. Therefore, with independent, paired selections of primary units, the average of a half-sample statistic and its complementary estimate has a variance that is estimated unbiasedly by the squared difference of the companion estimators divided by four. With the weighting class and hot deck imputations made independently within each half sample and its complement, this argument continues to hold.

To improve the precision of these pseudoreplication variance approximations, the technique for generating balanced and partially balanced sets of half-samples was developed by McCarthy (1966) so that by averaging K estimates of the form

$$\text{Var}(\hat{\mu}) = (\hat{\mu}_{Hi} - \hat{\mu}_{Ci})^2 / 4 \qquad (D.2)$$

where $\hat{\mu}_{Hi}$ is the estimate obtained using half-sample i and $\hat{\mu}_{Ci}$ is the estimate obtained using the complementary half sample, one obtains a variance approximation that is approximately $\sqrt{K}$ times as precise as any one of the separate components. For linear sample statistics with no imputation involved, the average of a half-sample statistic and its complementary estimate is equivalent to the usual full sample estimate based on two PSUs per stratum ($\hat{\mu}$) so that the half sample variance estimator described previously also applies rigorously to the full sample estimate. Further, the equation in (D.2) is equivalent to that given in (D.1).

Unfortunately, the real utility of the BRR technique lies in estimating the variance of nonlinear statistics such as means and proportions where the average of half-sample and complement statistics are not equivalent to the corresponding full sample ratio. Second order Taylor Series approximations suggest that averages of half-sample ratios should be subject to roughly twice the estimation bias of corresponding full sample ratios. Therefore, to preserve the rigorous justification for BRR variance estimates, one should report the associated half-sample average along with the pseudoreplication standard error. Following the common practice of users of BRR methods, we have neglected this rigorous theoretical justification to report means and proportions based on full sample ratios and full sample imputation. This reporting strategy can be empirically justified by noting that the relative difference between the full sample and half-sample statistics is small compared to the BRR relative standard error.

2. Implementation of the BRR Procedure to This Investigation

For this investigation, a total of 608 half samples (since there are 608 strata in the NLS sample) would have been required to achieve full balance and eliminate all between-strata contributions to the variance which was impractical since the processing of results from such a large number of half samples would have been too costly. The following system was used to construct a set of 16 partially balanced half samples that eliminated some (but not all) of

the between-strata contribution to the variability of variance estimates.

First, a set of 15 super strata were formed containing approximately the same number of strata using the following procedure. The strata were sorted first according to type of school (low versus high SES), then size of school, type of control (public versus private), geographic region, and finally, proximity to college or university. The first 300 strata were regions with low socioeconomic status (SES), and the second 300 were regions with high socioeconomic status. The final eight strata were composed of schools which had not been listed on the frame for the base-year sample. In creating the super strata, 7 were formed from the first 300 strata with low SES. The sorted group of low SES strata were partitioned so that the first 43 strata were designated as super stratum number 1, the second 43 strata as super stratum number 2, and so on until the seventh super stratum contained the remaining 42 strata from the low SES group. The remaining 8 super strata were selected from the 300 strata with high SES and the 8 strata of supplemental schools in a similar manner with the 15th super stratum containing the last 31 strata with high SES from the sorted file and the 8 strata containing supplemental schools.

These 15 super strata were then used in the BRR procedure to create the 16 half samples. Since the BRR procedure is designed for two replicates per stratum, the following adaptation of the procedure was needed for this investigation. Most of the NLS strata contain two schools, but a few have only one school due to nonresponse. Also, some schools would not participate in the Base Year Survey and so substitutions were made for these schools. Subsequently, some students from these schools which did not participate in the Base Year Survey were included in the follow-up surveys so that some of the NLS strata contain three or four schools. To partition the schools into two replicates, the file was first sorted by final stratum and then by school. Within each super stratum, the schools were numbered as they occurred in the file. Within each super stratum, the even numbered schools were regarded as the first "replicate" and the odd numbered schools as the second "replicate." A balanced repeated replicate design for 15 strata, which required 16 half-samples, was then used where all of the even numbered schools from a super stratum were included in the half sample if the BRR design specified that the first replicate from that stratum was to be used and the odd numbered schools otherwise.

BIBLIOGRAPHY OF EXTERNAL SOURCES

Frankel, Martin R. (1971). An empirical investigation of some properties of multivariate statistical estimates from complex samples. Ph.D. Dissertation, University of Michigan.

McCarthy, Philip J. (1966). Replication: An Approach to the Analysis of Data From Complex Surveys. National Center for Health Statistics, Series 2, Number 14.

Plackett, R. L. and J. P. Burma (1946). The design of optimum multifactorial experiments. Biometrika 33, 305-325.

Appendix E

STDERR: STANDARD ERRORS PROGRAM FOR SAMPLE SURVEY DATA

Appendix E

STDERR: STANDARD ERRORS PROGRAM FOR SAMPLE SURVEY DATA

An RTI computer program (STDERR) was used to estimate the proportions, means, and their sampling errors for the 20 selected critical items and domains. Since the sample size for each domain was not fixed, it was necessary to compute the estimated proportions, $\hat{P}_d$, and means, $\hat{m}_d$, as the ratios of two random variables.

For the ratio estimate of a proportion, the numerator estimated the total number of students in domain d who would have chosen the particular response option and the denominator estimated the total number of students in the domain. Explicitly,

$$\hat{P}_d = 100 \frac{\sum_{h=1}^{L} \sum_{i=1}^{a_h} \sum_{j=1}^{b_{hi}} W_{hij} D_{hij} Y_{hij}}{\sum_{h=1}^{L} \sum_{i=1}^{a_h} \sum_{j=1}^{b_{hi}} W_{hij} D_{hij}}$$

$$= 100 \frac{\hat{Y}(d)}{\hat{D}(d)}$$

where

L = number of final strata

a_h = number of sample schools in final stratum-h

b_{hi} = number of sample students in school-hi

W_{hij} = nonresponse adjusted weight for student-j in school-i from stratum-h

$$D_{hij} = \begin{cases} 1 \text{ if student-hij belonged to domain-d} \\ 0 \text{ otherwise} \end{cases}$$

$$Y_{hij} = \begin{cases} 1 \text{ if student-hij answered the questionnaire item in a specified manner (e.g., yes)} \\ 0 \text{ otherwise} \end{cases}$$

$\hat{Y}(d)$ = estimated number of students who answered the questionnaire item in a specified manner for domain-d.

$\hat{D}(d)$ = estimated number of students in domain-d.

The standard error of $\hat{P}_d$ was estimated by the square root of the variance of $\hat{P}_d$, where (Woodruff, 1971 and Cochran, 1977)

$$\text{Var}(\hat{P}_d) = (100)^2 \left\{ \sum_{h=1}^{M} a_h \sum_{h=1}^{a_h} \frac{[\hat{Z}_{hi+}(d) - \hat{Z}_{h\cdot+}(d)]^2}{(a_h-1)} \right.$$

$$+ \sum_{h=M+1}^{L} \frac{A_h-a_h}{A_h} a_h \sum_{i=1}^{a_h} \frac{[\hat{Z}_{hi+}(d) - \hat{Z}_{h\cdot+}(d)]^2}{(a_h-1)}$$

$$\left. + \sum_{h=M+1}^{L} \frac{a_h}{A_h} \sum_{i=1}^{a_h} \left(\frac{B_{hi}-b_{hi}}{B_{hi}}\right) b_{hi} \sum_{j=1}^{b_{hi}} \frac{[\hat{Z}_{hij}(d) - \hat{Z}_{hi\cdot}(d)]^2}{(b_{hi}-1)} \right\}$$

and

M = total number of final strata with schools selected with probabilities proportional to size

A_h = total number of schools in sampling frame for final stratum-h

B_{hi} = total number of senior students enrolled in school-hi

$\hat{Z}_{hij}(d) = W_{hij}(Y_{hij}-\hat{P}_d)/\hat{D}(d)$ = weighted Taylorized deviation

$\hat{Z}_{hi+}(d) = \sum_{j=1}^{b_{hi}} \hat{Z}_{hij}(d)$ = weighted deviation totals by school

$$\hat{Z}_{h\cdot+}(d) = \sum_{i=1}^{a_h} \frac{\hat{Z}_{hi+}(d)}{a_h} = \text{average school totals by stratum}$$

$$\hat{Z}_{hi\cdot}(d) = \frac{\hat{Z}_{hi+}(d)}{b_{hi}} = \text{average weighted deviations by school}$$

$$\hat{D}(d) = \sum_{h=1}^{L} \sum_{i=1}^{a_h} \sum_{j=1}^{b_{hi}} W_{hij} \; D_{hij}$$

The equation for $\text{Var}(\hat{P}_d)$ assumes, without loss of generality, that the final strata have been reordered so that the first M are those in which schools were selected with unequal probabilities proportional to size (PPS). The first term in the equation involves the between cluster estimate of variance for the PPS strata. The second term involves between cluster estimate of variance using the first stage finite population correction factor for the strata where schools were selected with equal probabilities, while the third term adds back the appropriate proportion of the within school variance for the equal probability strata. This equation gives an unbiased estimate of the variance for the equal probability final strata and a slight overestimate of the variance for the PPS strata. Also, it should be noted that $\hat{Z}_{hij}(d)$ is the Taylorized deviation of the ratio estimate $\hat{P}_d$. Such approximations are most valid for large samples.

The estimated mean for domain-d, $\hat{m}_d$, is also obtained as the ratio of two random variables. Explicitly,

$$\hat{m}_d = \frac{\sum_{h=1}^{L} \sum_{i=1}^{a_h} \sum_{j=1}^{b_{hi}} W_{hij} \; D_{hij} \; Y_{hij}}{\sum_{h=1}^{L} \sum_{i=1}^{a_h} \sum_{j=1}^{b_{hi}} W_{hij} \; D_{hij}}$$

where Y_{hij} represents the value of the quantitative variable under consideration for student-hij and the other parameters are as previously defined in the estimation formulas for proportions. The standard error of $\hat{m}_d$ was estimated by the square root of the variance of $\hat{m}_d$. The variance estimator for $\hat{m}_d$ has the same form as that presented for the sample proportion, $\hat{P}_d$, with $\hat{m}_d$ replacing $\hat{P}_d$ in the definition of the Taylorized deviation $Z_{hij}(d)$.

BIBLIOGRAPHY OF EXTERNAL SOURCES

Cochran, William G. (1977). Sampling Techniques, Third Edition, John Wiley and Sons, New York.

Woodruff, Ralph S. (1971). A simple method for approximating the variance of a complicated estimate. Journal of the American Statistical Association, 66, 411-414.

Appendix F

COMPARISON OF NO IMPUTATION ESTIMATES WHEN INCONSISTENT DATA ARE REMOVED (NIC) AND WHEN RETAINED (NI)

Glossary of Terms Used in the Tables

SAMPLE SIZE - number of sample members eligible to respond to a particular item for the domain under consideration.

$\bar{Y}$-TRUE - the estimate obtained using the telephone corrected and completed data.

NI - estimates obtained using no imputation or editing procedure on the experimental data set.

NIC - estimates obtained using no imputation or editing procedure on the experimental data set after inconsistent data are removed.

ME - measurement error caused by the use of data containing logical inconsistencies.

RB% - the relative bias defined to be the bias divided by the value of $\bar{Y}$-TRUE, expressed as a percentage.

BR - the bias ratio defined as the bias divided by the standard error of the estimate.

$R\sqrt{MSE}_{\%}$ - the relative root mean square error defined as the square root of the mean square error divided by the value of $\bar{Y}$-TRUE and expressed as a percentage.

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for proportions estimated for the total population

ITEM	RESPONSE	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVARSE%	NIC RVARSE%
TU1A	1	15089	72.29	-1.74	-2.40	-2.38	0.96	-4.21	1.52	2.45	1.14
TU1C	1	15089	17.16	-0.07	-0.40	-0.31	-0.97	-0.14	-4.40	2.21	9.19
TU1D	1	15089	4.12	0.30	7.28	7.06	-8.37	1.67	-1.70	8.23	9.70
TU1G	1	15089	9.19	-1.25	-13.59	-13.67	-13.37	-5.06	-4.90	13.93	13.64
TU9A	1	15089	67.82	-4.49	-6.62	-6.69	-0.98	-9.05	-1.13	6.73	1.30
TU9C	1	15089	32.15	-0.56	-1.74	-1.63	-9.72	-1.03	-6.81	2.27	9.83
TU9U	1	15089	3.96	0.01	0.25	0.53	-18.47	0.11	-4.43	4.67	18.93
TU9G	1	15089	7.00	-1.57	-22.41	-22.54	-22.84	-5.21	-4.67	22.96	23.36
TU10	1	15089	61.22	0.06	0.09	0.09	1.99	0.10	2.28	0.87	2.18
TU10	2	15089	13.06	-0.05	-0.38	-0.24	-9.53	-0.09	-3.83	2.66	9.85
TU10	3	15089	1.45	-0.06	-4.13	-5.97	-14.93	-0.77	-1.82	9.76	17.02
TU10	4	15089	24.27	0.05	0.20	0.26	0.98	0.16	0.64	1.62	1.81
TU12	1	3644	25.66	1.38	5.37	5.03	-12.77	1.41	-3.38	6.16	13.32
TU12	2	3644	7.20	-0.01	-0.13	0.52	5.38	0.07	0.72	7.05	9.17
TU12	3	3644	67.1	-1.37	-2.04	-1.98	4.30	-1.18	2.39	2.59	4.66
TU29	1	11439	91.40	0.01	0.01	-0.03	0.06	0.09	0.15	0.39	0.40
TU29	2	11439	8.60	-0.01	-0.11	-0.39	-0.64	-0.09	-0.15	4.22	4.32
TU33	1	4234	17.56	1.26	7.17	6.79	-22.97	1.51	-4.52	8.14	23.53
TU33	2	4234	3.57	0.31	8.68	9.81	5.95	1.33	0.70	12.26	10.33
TU33	3	4234	78.87	-1.57	-1.99	-1.95	4.84	-1.90	3.71	2.20	5.01
TU51	1	15089	47.13	0.42	0.89	0.48	-0.23	0.36	-0.18	1.40	1.31
TU51	2	15089	52.87	-0.42	-0.79	-0.43	0.21	-0.36	0.18	1.25	1.17
TU52	1	7579	49.75	0.24	0.48	0.61	-0.18	0.45	-0.12	1.47	1.47
TU52	2	7579	50.25	-0.24	-0.47	-0.60	0.18	-0.45	0.12	1.46	1.46
TU66	1	7579	20.29	0.29	1.42	1.32	-1.17	0.77	-0.59	2.16	2.29
TU66	2	7579	32.03	1.08	3.37	4.15	3.73	2.42	2.15	4.52	4.11
TU66	3	7579	47.68	-1.38	-2.89	-3.35	-2.00	-2.26	-1.50	3.66	2.40
TU90	1	7579	65.64	0.12	0.18	0.19	0.81	0.16	0.73	1.16	1.38
TU90	2	7579	4.67	0.26	5.57	5.73	-0.64	0.77	-0.09	9.33	6.58
TU90	3	7579	5.79	0.02	0.34	0.93	-1.15	0.14	-0.18	6.59	6.36
TU90	4	7579	23.90	-0.40	-1.67	-1.87	-1.84	-0.52	-0.52	4.03	3.99
TU101	1	15089	84.17	-0.01	-0.01	-0.12	-0.15	-0.30	-0.38	0.42	0.43
TU101	2	15089	15.83	0.01	0.06	0.66	0.82	0.30	0.38	2.26	2.30
TU102	1	2199	66.64	-0.53	-0.79	-0.46	0.34	-0.23	0.16	2.04	2.08
TU102	2	2199	33.36	0.53	1.58	0.92	-0.69	0.23	-0.16	4.09	4.15
TU118	1	15089	92.68	0.00	0.00	-0.09	-0.05	-0.42	-0.21	0.25	0.24
TU118	2	15089	0.90	0.01	1.11	1.98	-2.23	0.19	-0.20	10.33	11.01
TU118	3	15089	6.42	-0.01	-0.15	1.16	1.04	0.29	0.26	4.06	4.00
TU129	1	15089	9.78	0.02	0.20	-0.17	-0.55	-0.04	-0.14	3.92	3.97
TU129	2	15089	45.95	0.00	0.00	-0.06	-0.02	-0.07	-0.02	3.91	0.91
TU129	3	15089	4.02	-0.01	-0.24	0.07	0.02	0.01	0.00	5.08	5.07
TU129	4	15089	40.25	-0.01	-0.02	0.10	0.16	0.15	0.22	0.70	0.73
TU131A	1	6336	73.00	0.11	0.15	0.07	0.03	0.08	0.03	0.91	0.93
TU131C	1	6336	7.87	-0.02	-0.25	-0.03	0.19	0.00	0.03	6.38	6.44
TU131D	1	6336	4.30	0.00	0.00	0.00	0.32	0.00	0.02	11.53	11.54
TU131F	1	6336	26.45	-0.02	-0.07	0.16	0.26	0.04	0.07	3.38	3.41
TU136BOX	1	7010	18.19	0.02	0.10	0.00	0.06	0.00	0.01	3.45	3.45
TU136A	1	5743	71.91	0.00	0.00	0.00	-0.01	0.00	-0.01	1.06	1.06
TU136C	1	5743	9.09	0.00	0.00	0.37	0.39	0.06	0.06	5.71	5.72
TU136D	1	5743	3.89	0.00	0.00	-0.19	-0.16	-0.02	-0.02	7.76	7.76
TU136F	1	5743	21.81	0.01	0.04	-0.39	-0.43	-0.11	-0.12	3.52	3.5

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for proportions estimated for males

ITEM	RESPONSE	SAMPLE SIZE	Ȳ-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
T01A	1	7357	77.00	-2.51	-3.25	-3.28	0.48	-5.38	0.76	3.33	0.79
T01C	1	7357	19.84	-0.13	-0.65	-0.55	-9.02	-0.17	-3.47	3.21	9.38
T01D	1	7357	4.63	0.56	12.10	12.34	-6.44	2.67	-1.27	13.17	8.19
T01G	1	7357	9.28	-0.91	-9.80	-9.88	-9.03	-1.84	-1.59	11.24	10.65
T09A	1	7357	71.16	-4.48	-6.29	-6.34	-0.97	-5.21	-0.72	6.46	1.66
T09C	1	7357	35.17	-0.43	-1.22	-1.34	-9.09	-0.59	-3.91	2.63	9.39
T09D	1	7357	4.50	0.07	1.55	1.89	-17.81	0.52	-3.99	4.09	18.36
T09G	1	7357	7.12	-1.39	-19.52	-19.83	-18.90	-3.63	-3.06	20.56	19.89
T010	1	7357	68.57	0.01	0.01	0.00	2.19	0.00	3.08	0.72	2.31
T010	2	7357	11.75	-0.05	-0.42	-0.67	-14.79	-0.15	-3.82	4.35	15.29
T010	3	7357	1.39	-0.01	-0.71	-1.67	-5.58	-0.12	-0.39	13.54	15.13
T010	4	7357	18.28	0.07	0.38	0.55	1.68	0.22	0.61	2.59	3.21
T012	1	1295	36.19	0.80	2.21	1.93	-9.64	0.44	-2.34	4.77	10.48
T012	2	1295	6.98	0.09	1.28	2.14	5.96	0.25	0.67	8.58	10.62
T012	3	1295	56.83	-0.89	-1.56	-1.49	5.40	-0.49	1.78	3.37	6.20
T029	1	6058	90.26	0.03	0.03	0.08	0.13	0.23	0.36	0.36	0.39
T029	2	6058	9.74	-0.03	-0.30	-0.77	-1.27	-0.23	-0.36	3.36	3.70
T033	1	1633	21.65	1.82	8.40	7.50	-17.66	1.47	-3.40	9.07	18.41
T033	2	1633	3.90	0.17	4.36	5.44	5.66	0.34	0.41	16.86	14.82
T035	3	1633	74.45	-1.99	-2.67	-2.46	4.84	-1.44	2.78	3.00	5.14
T05_	1	7357	43.76	0.48	1.09	0.53	-0.64	0.27	-0.35	1.97	1.93
T051	2	7357	56.24	-0.48	-0.85	-0.41	0.50	-0.27	0.35	1.54	1.50
T052	1	3970	45.84	0.22	0.47	0.50	-0.18	0.24	-0.07	2.16	2.32
T052	2	3970	54.16	-0.22	-0.40	-0.43	0.15	-0.24	0.07	1.82	1.96
T066	1	3970	18.94	0.47	2.48	1.97	-1.96	0.77	-0.71	3.23	3.36
T066	2	3970	35.38	1.13	3.19	3.95	3.62	1.61	1.24	4.65	4.64
T066	3	3970	45.68	-1.60	-3.50	-3.88	-1.99	-1.69	-0.88	4.51	3.06
T090	1	3970	66.03	0.23	0.34	0.32	0.72	0.29	0.66	1.16	1.31
T090	2	3970	4.64	0.30	6.46	6.28	-0.76	0.48	-0.06	14.36	11.63
T090	3	3970	5.22	-0.01	-0.19	-0.61	-2.00	-0.06	-0.23	9.72	8.78
T090	4	3970	24.11	-0.51	-2.11	-1.97	-1.41	-0.60	-0.43	3.83	3.54
T0101	1	7357	84.87	0.00	0.00	-0.08	-0.11	-0.10	-0.14	0.77	0.77
T0101	2	7357	15.13	0.00	0.00	0.46	0.63	0.10	0.14	4.36	4.35
T0102	1	1031	61.36	-0.53	-0.86	-0.30	0.57	-0.08	0.14	3.64	4.03
T0102	2	1031	38.64	0.53	1.37	0.48	-0.91	0.08	-0.14	5.77	6.40
T0118	1	7357	87.00	0.00	0.00	-0.03	0.01	-0.08	0.02	0.42	0.42
T0118	2	7357	1.56	0.00	0.00	-0.68	-3.83	-0.05	-0.31	12.61	12.93
T0118	3	7357	11.44	0.00	0.00	0.35	0.43	0.09	0.11	3.97	3.99
T0129	1	7357	9.93	0.03	0.30	-0.32	-0.65	-0.06	-0.12	5.25	5.23
T0129	2	7357	54.44	0.00	0.00	0.02	0.03	0.01	0.02	1.70	1.70
T0129	3	7357	2.82	-0.01	-0.35	-0.18	-0.09	-0.02	-0.01	6.67	6.69
T0129	4	7357	32.81	-0.02	-0.06	0.07	0.14	0.03	0.07	2.02	2.04
T0131A	1	2592	55.12	0.09	0.16	-0.04	-0.21	-0.02	-0.12	1.64	1.71
T0131C	1	2592	7.41	0.00	0.00	0.25	0.58	0.02	0.06	8.66	8.79
T0131D	1	2592	2.50	0.00	0.00	0.25	0.58	0.01	0.02	23.40	23.47
T0131F	1	2592	62.05	-0.11	-0.17	0.03	0.31	0.02	0.20	1.43	1.53
T0136BOX	1	2817	20.73	0.00	0.00	0.00	0.00	0.00	0.00	3.58	3.58
T0136A	1	2231	54.83	0.00	0.00	-0.03	-0.05	-0.01	-0.02	2.00	2.00
T0136C	1	2231	8.72	0.00	0.00	0.62	0.65	0.08	0.08	7.44	7.45
T0136D	1	2231	2.32	0.00	0.00	0.62	0.65	0.03	0.03	18.75	18.76
T0136F	1	2231	53.44	0.00	0.00	-0.24	-0.21	-0.10	-0.09	2.28	2.27

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for proportions estimated for individuals of low socio-economic status

ITEM	RESPONSE	SAMPLE SIZE	Y-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVARSE%	NIC RVARSE%
TU1A	1	4220	69.91	-1.06	-1.51	-1.47	1.25	-1.24	1.05	1.69	1.72
TU1C	1	4220	10.77	-0.06	-0.55	-0.50	-17.95	-0.07	-3.40	6.68	18.71
TU1D	1	4220	3.84	0.42	10.92	11.04	-13.82	1.29	-1.86	13.95	15.68
TU1G	1	4220	11.47	-1.47	-12.81	-12.77	-11.03	-2.92	-2.37	13.49	11.97
TU9A	1	4220	68.85	-2.33	-3.38	-3.46	0.69	-2.59	0.54	3.71	1.44
TU9C	1	4220	16.26	-0.79	-4.85	-4.46	-16.69	-0.71	-3.59	7.70	17.33
TU9D	1	4220	3.66	0.22	6.01	6.66	-10.56	0.89	-2.98	10.01	19.57
TU9G	1	4220	10.13	-2.03	-20.03	-19.92	-20.59	-2.75	-3.32	21.20	21.50
TU10	1	4220	62.88	-0.03	-0.04	-0.13	1.06	-0.09	0.78	1.33	1.72
TU10	2	4220	9.10	0.03	0.3[illegible]	1.03	-7.17	0.23	-1.88	4.49	8.12
TU10	3	4220	1.93	0.07	3.61	4.17	-5.59	0.36	-0.55	12.31	11.53
TU10	4	4220	26.09	-0.07	-0.26	-0.35	0.3[illegible]	-0.11	0.11	3.09	3.08
TU12	1	1069	30.32	1.28	4.22	4.32	-10.27	1.22	-2.89	5.58	10.87
TU12	2	1069	7.30	-0.10	-1.37	-0.73	5.47	-0.06	0.45	11.39	13.10
TU12	3	1069	62.39	-1.19	-1.90	-2.01	4.35	-1.01	2.21	2.83	4.77
TU29	1	3150	91.46	-0.01	-0.01	0.00	-0.02	-0.01	-0.03	0.54	0.55
TU29	2	3150	8.54	0.01	0.11	0.09	0.23	0.01	0.03	5.81	5.91
TU33	1	1099	26.92	1.09	4.04	3.71	-19.32	1.06	-4.14	5.08	19.87
TU33	2	1099	3.71	0.33	8.90	10.93	9.16	0.96	0.57	15.71	18.43
TU33	3	1099	69.38	-1.44	-2.07	-2.02	7.00	-1.37	3.02	2.50	7.38
TU51	1	4220	64.83	0.28	0.43	0.04	-0.18	0.03	-0.11	1.57	1.65
TU51	2	4220	35.17	-0.28	-0.79	-0.09	0.33	-0.03	0.11	2.90	3.04
TU52	1	1420	49.78	0.45	0.90	1.20	0.75	0.33	0.20	3.81	3.74
TU52	2	1420	50.22	-0.45	-0.89	-1.19	-0.74	-0.33	-0.20	3.77	3.70
TU66	1	1420	30.72	0.83	2.70	2.34	1.46	0.48	0.29	5.36	5.18
TU66	2	1420	29.91	0.68	2.27	3.43	2.39	0.71	0.54	5.89	5.01
TU66	3	1420	39.37	-1.51	-3.83	-4.43	-2.96	-1.09	-0.78	5.99	4.81
TU90	1	1420	52.38	0.29	0.55	-0.01	0.60	0.00	0.13	4.41	4.53
TU90	2	1420	6.44	0.45	6.98	6.94	-1.28	0.57	-0.10	13.88	12.25
TU90	3	1420	8.32	0.17	2.04	2.52	-0.61	0.40	-0.08	6.77	7.63
TU90	4	1420	32.86	-0.91	-2.76	-1.97	-0.55	-0.33	-0.09	6.17	5.85
TU101	1	4220	94.03	0.00	0.00	-0.02	-0.03	-0.04	-0.05	0.56	0.56
TU101	2	4220	5.97	0.00	0.00	0.36	0.49	0.04	0.05	8.94	8.95
TU102	1	230	67.12	-2.01	-2.99	-1.02	2.13	-0.14	0.29	7.36	7.54
TU102	2	230	32.88	2.01	6.11	2.10	-4.36	0.14	-0.29	15.02	15.39
TU118	1	4220	90.23	0.00	0.00	-0.14	-0.15	-0.23	-0.24	0.63	0.63
TU118	2	4220	1.43	0.00	0.00	3.51	3.59	0.18	0.18	19.74	19.78
TU118	3	4220	8.33	0.00	0.00	0.94	1.01	0.13	0.14	7.26	7.29
TU129	1	4220	9.35	0.00	0.00	-0.37	-0.29	-0.05	-0.03	7.31	7.32
TU129	2	4220	35.96	0.00	0.00	-0.17	-0.21	-0.08	-0.09	2.19	2.22
TU129	3	4220	6.12	-0.04	-0.65	-0.29	-0.21	-0.03	-0.02	9.05	9.06
TU129	4	4220	48.57	0.04	0.08	0.24	0.23	0.15	0.15	1.56	1.54
TU131A	1	2093	71.01	0.24	0.33	0.19	0.07	0.09	0.03	2.05	2.07
TU131C	1	2093	5.12	-0.08	-1.56	-1.34	-0.96	-0.08	-0.06	15.50	15.61
TU131D	1	2093	3.97	0.00	0.00	-0.38	0.00	-0.03	0.00	11.74	11.76
TU131F	1	2093	26.91	-0.04	-0.14	0.10	0.05	0.02	0.01	5.07	5.05
TU136BOX	1	2354	14.14	0.00	0.00	0.00	0.00	0.00	0.00	6.99	6.99
TU136A	1	2021	71.81	0.00	0.00	-0.06	-0.09	-0.03	-0.05	1.59	1.60
TU136C	1	2021	5.72	0.00	0.00	0.15	0.23	0.01	0.02	10.14	10.14
TU136D	1	2021	3.65	0.00	0.00	-1.73	-1.65	-0.17	-0.16	10.18	10.18
TU136F	1	2021	21.46	0.04	0.18	0.35	0.23	0.06	0.04	5.21	5.15

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for proportions estimated for individuals of high ability

ITEM	RESPONSE	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVARSE%	NIC RVARSE%
TU1A	1	2839	71.74	-2.99	-4.16	-4.23	-0.15	-3.01	-0.09	4.46	1.69
TU1C	1	2839	26.28	-0.03	-0.11	0.03	-5.55	0.00	-2.07	3.49	6.16
TU1D	1	2839	4.11	0.06	1.45	1.53	-7.26	0.15	-0.78	9.92	11.74
TU1G	1	2839	8.38	-0.97	-11.57	-11.42	-10.20	-2.02	-1.80	12.74	11.67
TU9A	1	2839	63.08	-9.13	-14.47	-14.60	-5.13	-10.55	-2.73	14.67	5.46
TU9C	1	2839	58.79	-0.48	-0.81	-0.73	-4.45	-0.39	-2.55	2.01	4.78
TU9D	1	2839	2.86	0.01	0.34	0.38	-3.85	0.02	-0.32	13.60	12.37
TU9S	1	2839	4.91	-1.65	-33.62	-33.39	-32.74	-3.50	-2.82	34.72	34.72
TU10	1	2839	53.65	-0.12	-0.22	-0.30	2.78	-0.13	1.14	2.21	3.69
TU10	2	2839	20.46	-0.05	-0.24	-0.52	-10.54	-0.18	-4.10	2.84	10.85
TU10	3	2839	1.26	-0.04	-3.18	-2.35	-17.94	-0.11	-0.92	20.94	26.40
TU10	4	2839	24.70	0.20	0.80	1.21	3.56	0.27	0.75	4.58	5.91
TU12	1	732	22.03	1.07	4.85	4.96	-11.94	0.64	-1.52	9.14	14.30
TU12	2	732	6.26	0.08	1.27	1.47	4.26	0.08	0.25	17.27	17.48
TU12	3	732	71.72	-1.16	-1.61	-1.65	3.29	-0.60	1.04	3.18	4.55
TU29	1	2107	89.82	0.00	0.00	-0.03	0.02	-0.04	0.03	0.77	0.77
TU29	2	2107	10.18	0.00	0.00	0.32	-0.25	0.04	-0.03	6.86	6.86
TU33	1	993	9.39	1.63	17.36	17.85	-35.65	1.29	-3.43	22.57	37.13
TU33	2	993	2.35	0.18	7.64	7.94	5.49	0.53	0.37	16.80	15.53
TU33	3	993	88.26	-1.81	-2.05	-2.11	3.64	-1.42	3.10	2.57	3.82
TU51	1	2839	21.90	0.32	1.46	1.49	0.11	0.36	0.02	4.34	4.14
TU51	2	2839	78.10	-0.32	-0.40	-0.41	-0.03	-0.36	-0.02	1.21	1.16
TU52	1	2155	47.38	0.05	0.10	-0.07	-0.84	-0.03	-0.37	2.20	2.41
TU52	2	2155	52.62	-0.05	-0.09	0.06	0.75	0.03	0.37	1.98	2.17
TU66	1	2155	11.65	-0.27	-2.31	-2.60	-4.68	-0.43	-0.73	6.50	7.89
TU66	2	2155	32.40	0.98	3.02	3.77	2.83	1.04	0.75	5.21	4.71
TU66	3	2155	55.95	-0.71	-1.26	-1.64	-0.66	-0.90	-0.37	2.44	1.89
TU90	1	2155	62.00	0.00	0.00	-0.07	0.68	-0.04	0.37	1.84	1.96
TU90	2	2155	5.15	0.09	1.74	2.49	0.02	0.13	0.00	18.60	16.56
TU90	3	2155	5.26	0.00	0.00	-0.16	-2.19	-0.01	-0.19	12.30	11.76
TU90	4	2155	27.59	-0.09	-0.32	-0.26	-1.13	-0.05	-0.24	4.62	4.72
TU101	1	2839	64.32	0.00	0.00	0.05	-0.02	0.02	-0.01	2.05	2.06
TU101	2	2839	35.68	0.00	0.00	-0.09	0.05	-0.02	0.01	3.71	3.72
TU102	1	951	60.71	-0.18	-0.29	0.25	0.54	0.14	0.29	1.78	1.91
TU102	2	951	39.29	0.18	0.45	-0.39	-0.84	-0.14	-0.29	2.76	2.95
TU118	1	2839	94.43	0.00	0.00	-0.02	0.01	-0.05	0.03	0.42	0.41
TU118	2	2839	0.41	0.00	0.00	-13.67	-24.49	-0.60	-1.12	26.50	32.81
TU118	3	2839	5.17	0.00	0.00	1.53	1.69	0.20	0.22	7.58	7.65
TU129	1	2839	10.73	0.04	0.37	0.03	-0.30	0.00	-0.04	6.75	6.77
TU129	2	2839	58.04	0.00	0.00	-0.08	-0.03	-0.04	-0.02	1.78	1.79
TU129	3	2839	2.37	0.00	0.00	0.33	0.37	0.02	0.03	11.83	11.83
TU129	4	2839	28.86	-0.04	-0.13	0.11	0.16	0.03	0.04	3.28	3.28
TU131A	1	867	78.46	0.00	0.00	-0.05	-0.05	-0.02	-0.02	2.12	2.12
TU131C	1	867	12.63	0.00	0.00	0.21	0.21	0.02	0.02	10.32	10.32
TU131D	1	867	4.61	0.00	0.00	0.21	0.21	0.00	0.00	22.54	22.54
TU131F	1	867	22.94	0.00	0.00	0.21	0.21	0.01	0.01	11.15	11.15
TU136BOX	1	940	22.20	0.00	0.00	0.00	0.00	0.00	0.00	6.99	6.99
TU136A	1	731	72.05	0.00	0.00	-0.06	-0.06	-0.01	-0.01	3.40	3.40
TU136C	1	731	17.65	0.00	0.00	0.16	0.16	0.01	0.01	9.61	9.61
TU136D	1	731	4.05	0.00	0.00	0.16	0.16	0.00	0.00	26.85	26.85
TU136F	1	731	17.55	0.00	0.00	0.16	0.16	0.01	0.01	11.34	11.34

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for proportions estimated for blacks

ITEM	RESPONSE	SAMPLE SIZE	Y-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
TU1A	1	1963	69.37	-1.45	-2.09	-1.98	2.27	-1.00	1.13	2.81	3.03
TU1C	1	1963	17.03	-0.27	-1.58	-1.83	-13.78	-0.35	-2.66	5.40	14.72
TU1D	1	1963	5.51	-0.14	-2.53	-2.38	-17.67	-0.19	-2.09	12.31	19.58
TU1G	1	1963	14.45	-2.34	-16.19	-16.94	-14.08	-2.10	-1.62	18.76	16.52
TU9A	1	1963	64.93	-2.93	-4.51	-4.44	1.61	-2.13	0.82	4.90	2.53
TU9C	1	1963	26.71	-1.56	-5.84	-5.16	-14.08	-0.77	-2.90	8.43	14.89
TU9D	1	1963	6.83	0.15	2.19	2.80	-16.26	0.27	-1.36	10.52	20.14
TU9G	1	1963	13.81	-3.41	-24.68	-25.26	-22.94	-3.31	-2.95	26.38	24.22
TU10	1	1963	59.55	0.57	0.95	0.89	2.15	0.43	0.90	2.26	3.19
TU10	2	1963	12.36	-0.34	-2.75	-1.14	-9.79	-0.19	-2.11	5.87	10.84
TU10	3	1963	1.85	0.11	5.93	8.29	6.23	0.29	0.20	29.68	31.66
TU10	4	1963	26.24	-0.34	-1.29	-2.08	-0.71	-0.46	-0.14	4.97	4.91
TU12	1	505	38.87	1.86	4.78	4.59	-10.61	0.64	-1.48	8.47	12.79
TU12	2	505	12.45	-0.55	-4.41	-0.61	12.32	-0.03	0.67	16.04	22.04
TU12	3	505	48.68	-1.31	-2.69	-3.51	5.32	-0.64	0.98	6.47	7.59
TU29	1	1455	92.03	0.00	0.00	-0.05	-0.04	-0.06	-0.05	0.88	0.88
TU29	2	1455	7.97	0.00	0.00	0.62	0.56	0.06	0.05	10.18	10.21
TU33	1	569	37.85	0.66	1.74	1.14	-21.01	0.22	-4.23	5.14	21.58
TU33	2	569	5.80	1.08	18.60	20.90	14.65	0.82	0.88	32.77	22.05
TU33	3	569	56.35	-1.74	-3.08	-2.92	12.60	-0.95	3.83	4.23	13.02
TU51	1	1963	50.21	-0.78	-1.55	-0.11	-1.14	-0.03	-0.35	3.26	3.47
TU51	2	1963	49.79	0.00	0.00	0.11	1.15	0.03	0.35	3.29	3.50
TU52	1	928	44.94	1.55	3.44	4.01	1.93	0.94	0.39	5.85	5.29
TU52	2	928	55.06	-1.55	-2.81	-3.27	-1.58	-0.94	-0.39	4.78	4.32
TU66	1	928	23.08	1.82	7.88	8.01	0.00	1.05	0.00	11.05	7.87
TU66	2	928	35.77	0.76	2.12	2.31	4.91	0.42	0.95	5.94	7.13
TU66	3	928	41.15	-2.58	-6.26	-6.50	-4.27	-1.65	-1.06	7.60	5.86
TU90	1	928	42.92	0.32	0.74	-0.10	2.22	-0.02	0.45	4.36	5.36
TU90	2	928	6.37	1.82	28.57	30.06	2.57	1.33	0.18	36.69	14.54
TU90	3	928	10.97	0.17	1.55	-0.72	-3.37	-0.06	-0.25	12.04	13.44
TU90	4	928	39.75	-2.32	-5.83	-4.50	-1.88	-0.67	-0.30	8.04	6.50
TU101	1	1963	90.16	0.00	0.00	-0.80	-0.40	-0.27	-0.36	1.14	1.19
TU101	2	1963	9.84	0.00	0.00	2.81	3.75	0.27	0.36	10.51	10.95
TU102	1	180	64.15	-1.26	-1.96	-1.97	0.00	-0.31	0.00	6.50	7.22
TU102	2	180	35.85	1.26	3.51	3.53	0.00	0.31	0.00	11.64	12.93
TU118	1	1963	89.04	0.00	0.00	-0.35	-0.21	-0.32	-0.20	1.13	1.09
TU118	2	1963	1.24	0.00	0.00	1.25	1.51	0.04	0.05	28.14	28.28
TU118	3	1963	9.72	0.00	0.00	3.07	1.79	0.32	0.19	9.83	9.38
TU129	1	1963	12.11	0.00	0.00	-0.21	-0.79	-0.02	-0.09	8.80	8.61
TU129	2	1963	51.15	0.00	0.00	0.02	-0.06	0.00	-0.02	2.29	2.25
TU129	3	1963	4.24	0.00	0.00	1.72	2.03	0.14	0.17	11.68	11.82
TU129	4	1963	32.50	0.00	0.00	-0.17	0.13	-0.04	0.03	4.25	4.23
TU131A	1	644	73.54	0.00	0.00	-0.03	-0.25	0.00	-0.06	3.88	3.80
TU131C	1	644	6.67	0.00	0.00	0.99	1.99	0.05	0.11	16.82	17.09
TU131D	1	644	4.02	0.00	0.00	-1.84	-0.87	-0.07	-0.03	25.63	25.76
TU131F	1	644	24.42	0.25	1.02	1.55	1.47	0.15	0.15	10.10	9.82
TU136BOX	1	745	17.27	0.00	0.00	0.00	0.00	0.00	0.00	6.71	6.71
TU136A	1	615	73.44	0.00	0.00	0.25	0.15	0.11	0.06	2.23	2.22
TU136C	1	615	8.54	0.00	0.00	0.90	1.21	0.06	0.08	14.25	14.35
TU136D	1	615	4.78	0.00	0.00	-1.64	-1.34	-0.08	-0.07	18.48	18.57
TU136F	1	615	18.05	0.16	0.88	-0.55	-1.18	-0.06	-0.13	9.12	8.86

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for proportions estimated for the South

ITEM	RESPONSE	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
TQ1A	1	3948	73.45	-2.11	-2.87	-2.87	0.78	-3.13	0.96	3.01	1.13
TQ1C	1	3948	17.20	0.24	1.39	1.50	-10.62	0.28	-2.06	5.43	11.80
TQ1D	1	3948	4.21	0.11	2.61	2.88	-9.75	0.36	-1.03	8.33	13.58
TQ1G	1	3948	8.07	-0.98	-12.14	-11.97	-13.31	-2.33	-2.11	13.03	14.72
TQ9A	1	3948	68.68	-4.83	-7.03	-7.09	-0.92	-8.57	-1.31	7.13	1.16
TQ9C	1	3948	30.59	-0.29	-0.94	-0.89	-11.35	-0.30	-4.10	3.06	11.68
TQ9D	1	3948	4.04	-0.19	-4.70	-4.59	-22.29	-0.59	-3.46	8.98	23.20
TQ9G	1	3948	7.28	-1.62	-22.24	-22.17	-19.68	-6.24	-3.99	22.46	20.28
TQ10	1	3948	61.38	0.24	0.39	0.26	2.63	0.29	2.48	0.94	2.83
TQ10	2	3948	14.20	-0.01	-0.07	0.23	-11.76	0.05	-2.86	4.16	12.46
TQ10	3	3948	1.35	-0.15	-11.11	-10.81	-20.56	-1.05	-1.71	14.88	23.81
TQ10	4	3948	23.07	-0.07	-0.30	-0.22	1.44	-0.09	0.57	2.55	2.89
TQ12	1	908	22.91	1.57	6.85	8.44	-9.43	1.24	-1.12	10.83	12.64
TQ12	2	908	7.94	-0.09	-1.13	-0.99	3.19	-0.09	0.27	10.33	12.15
TQ12	3	908	69.16	-1.48	-2.14	-2.68	2.75	-1.17	1.12	3.52	3.68
TQ29	1	3039	90.75	0.03	0.03	0.02	0.12	0.03	0.16	0.74	0.77
TQ29	2	3039	9.25	-0.03	-0.32	-0.22	-1.26	-0.03	-0.16	7.28	7.60
TQ33	1	1088	18.26	1.21	6.62	7.39	-21.82	0.85	-3.06	11.41	22.95
TQ33	2	1088	3.66	0.21	5.73	6.53	3.62	0.75	0.30	10.84	12.26
TQ33	3	1088	78.09	-1.43	-1.83	-2.03	4.93	-0.98	3.18	2.89	5.16
TQ51	1	3948	48.96	0.31	0.63	0.55	-0.01	0.26	0.00	2.14	2.10
TQ51	2	3948	51.04	-0.31	-0.60	-0.53	0.01	-0.26	0.00	2.06	2.01
TQ52	1	1922	47.56	0.51	1.07	1.21	-0.19	0.38	-0.05	3.42	3.65
TQ52	2	1922	52.44	-0.51	-0.97	-1.10	0.17	-0.38	0.05	3.10	3.31
TQ66	1	1922	18.95	0.83	4.38	4.75	1.85	1.13	0.40	6.33	4.97
TQ66	2	1922	35.69	0.86	2.40	3.32	4.18	0.75	0.83	5.52	6.50
TQ66	3	1922	45.36	-1.69	-3.72	-4.60	-4.06	-1.22	-1.09	5.94	5.51
TQ90	1	1922	65.01	0.24	0.36	0.86	1.33	0.39	0.60	2.36	2.56
TQ90	2	1922	4.02	-0.09	-2.23	-3.02	-1.84	-0.19	-0.11	15.95	16.09
TQ90	3	1922	6.96	-0.07	-1.00	0.28	-1.65	0.03	-0.20	8.78	8.23
TQ90	4	1922	24.00	-0.07	-0.29	-1.92	-2.83	-0.30	-0.48	6.51	6.53
TQ101	1	3948	85.24	-0.02	-0.02	-0.06	-0.03	-0.06	-0.03	0.91	0.90
TQ101	2	3948	14.76	0.02	0.13	0.35	0.19	0.06	0.03	5.30	5.22
TQ102	1	549	66.41	-0.29	-0.43	0.46	1.12	0.10	0.25	4.61	4.56
TQ102	2	549	33.59	0.29	0.86	-0.91	-2.22	-0.10	-0.25	9.11	9.02
TQ118	1	3948	93.04	0.00	0.00	-0.02	-0.02	-0.03	-0.03	0.69	0.69
TQ118	2	3948	1.00	0.00	0.00	-1.77	-1.77	-0.06	-0.06	25.63	25.63
TQ118	3	3948	5.96	0.00	0.00	0.71	0.71	0.09	0.09	7.89	7.89
TQ129	1	3948	9.85	0.03	0.30	-0.35	-0.60	-0.06	-0.10	5.73	5.78
TQ129	2	3948	43.62	0.00	0.00	-0.02	0.02	0.00	0.01	2.19	2.20
TQ129	3	3948	3.54	0.00	0.00	0.42	-0.03	0.05	0.00	7.27	7.00
TQ129	4	3948	42.99	-0.03	-0.06	0.06	0.11	0.03	0.05	2.10	2.10
TQ131A	1	1712	73.95	0.03	0.04	-0.10	-0.06	-0.07	-0.04	1.51	1.5
TQ131C	1	1712	7.72	0.00	0.00	0.40	0.57	0.03	0.05	11.08	11.1
TQ131D	1	1712	4.71	0.00	0.00	0.40	0.57	0.01	0.02	24.81	24.56
TQ131F	1	1712	26.23	-0.10	-0.38	0.02	0.19	0.00	0.03	5.03	5.07
TQ136BOX	1	1860	18.56	0.00	0.00	0.00	0.00	0.00	0.00	5.12	5.12
TQ136A	1	1518	72.70	0.00	0.00	-0.17	-0.17	-0.07	-0.07	2.37	2.37
TQ136C	1	1518	9.69	0.00	0.00	0.57	0.57	0.05	0.05	10.27	10.27
TQ136D	1	1518	4.30	0.00	0.00	0.57	0.57	0.05	0.05	11.42	11.42
TQ136F	1	1518	21.54	0.00	0.00	-0.25	-0.25	-0.04	-0.04	5.57	5.57

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for proportions estimated for blacks on average ability

ITEM	RESPONSE	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
TU1A	1	357	66.74	-1.94	-2.90	-2.91	3.30	-0.53	0.75	6.16	5.49
TU1C	1	357	25.28	-1.25	-4.94	-4.96	-15.57	-0.38	-1.15	13.89	20.55
TU1D	1	357	4.54	-0.35	-7.70	-7.65	-23.60	-0.31	-1.07	25.33	32.26
TU16	1	357	15.60	-4.28	-27.43	-27.42	-29.28	-2.21	-1.97	30.08	32.81
TU9A	1	357	64.72	-7.47	-11.54	-11.53	1.61	-2.21	0.27	12.65	6.07
TU9C	1	357	42.83	-1.58	-3.68	-3.68	-14.48	-0.56	-2.32	7.47	15.76
TU9D	1	357	7.38	-0.23	-3.11	-3.09	-16.27	-0.20	-0.93	15.69	23.78
TU9E	1	357	11.23	-5.26	-46.85	-46.81	-45.67	-4.20	-3.97	48.12	47.09
TU10	1	357	86.17	1.08	1.92	2.45	3.92	0.41	0.66	6.37	7.12
TU10	2	357	13.00	0.00	0.00	1.13	-11.08	0.05	-0.54	19.61	23.13
TU10	3	357	2.73	0.00	0.00	1.13	5.36	0.02	0.09	54.56	57.19
TU10	4	357	28.03	-1.09	-3.88	-5.55	-3.21	-0.61	-0.32	10.59	10.35
TU12	1	101	37.05	-1.16	-3.13	-1.57	-23.29	-0.07	-1.31	20.30	29.25
TU12	2	101	7.38	0.00	0.00	6.82	23.53	0.12	0.36	56.71	68.58
TU12	3	101	55.57	1.16	2.08	0.14	12.39	0.01	0.96	13.48	17.83
TU29	1	255	92.75	0.16	0.17	0.68	0.57	0.37	0.30	1.94	1.94
TU29	2	255	7.25	-0.16	-2.20	-8.72	-7.33	-0.37	-0.30	24.94	24.88
TU33	1	107	32.20	1.31	4.06	0.74	-38.53	0.04	-3.13	18.59	40.44
TU33	2	107	4.28	0.00	0.00	1.61	20.63	0.02	0.24	72.23	87.91
TU33	3	107	63.52	-1.31	-2.06	-0.48	18.14	-0.05	2.78	8.28	19.27
TU51	1	357	30.74	1.16	3.77	3.85	1.22	0.33	0.10	12.23	11.81
TU51	2	357	69.26	-1.16	-1.67	-1.71	-0.54	-0.33	-0.10	5.43	5.24
TU52	1	233	49.04	0.00	0.00	2.52	1.55	0.38	0.20	6.98	7.66
TU52	2	233	50.96	-0.51	-1.00	-2.43	-1.49	-0.38	-0.20	6.71	7.37
TU66	1	233	20.16	0.69	3.42	4.74	3.82	0.25	0.20	19.25	19.38
TU66	2	233	32.48	0.45	1.38	-0.51	-1.23	-0.03	-0.08	15.06	15.42
TU66	3	233	47.36	-1.14	-2.40	-1.66	-0.77	-0.26	-0.11	6.49	7.00
TU90	1	233	37.64	-0.51	-1.35	1.36	3.69	0.16	0.45	8.53	8.84
TU90	2	233	7.49	0.65	8.68	14.85	9.29	0.92	0.52	21.84	20.11
TU90	3	233	10.63	0.78	7.33	-1.99	-10.92	-0.10	-0.55	19.34	22.41
TU90	4	233	44.25	-0.94	-2.12	-3.20	-2.09	-0.45	-0.28	7.75	7.70
TU101	1	357	80.90	0.00	0.00	-0.28	-0.28	-0.06	-0.06	4.46	4.46
TU101	2	357	19.10	0.00	0.00	1.19	1.19	0.06	0.06	18.93	18.93
TU102	1	61	61.07	0.00	0.00	0.00	0.00	0.00	0.00	15.19	15.19
TU102	2	61	38.93	0.00	0.00	0.00	0.00	0.00	0.00	23.83	23.83
TU118	1	357	07.57	0.00	0.00	0.35	0.35	0.16	0.16	2.20	2.20
TU118	2	357	0.23	0.00	0.00	3.05	3.05	0.03	0.03	87.01	87.01
TU118	3	357	12.21	0.00	0.00	-2.57	-2.57	-0.17	-0.17	14.80	14.80
TU129	1	357	8.69	0.00	0.00	0.79	1.28	0.03	0.06	20.36	20.36
TU129	2	357	59.08	0.00	0.00	-0.54	-0.89	-0.11	-0.18	4.78	4.85
TU129	3	357	5.21	0.00	0.00	0.79	1.28	0.03	0.05	25.21	25.21
TU129	4	357	27.02	0.00	0.00	0.79	1.28	0.09	0.15	8.42	8.67
TU131A	1	103	71.73	0.00	0.00	0.00	0.00	0.00	0.00	8.44	8.44
TU131C	1	103	7.64	0.00	0.00	0.00	0.00	0.00	0.00	45.22	45.22
TU131D	1	103	0.30	0.00	0.00	0.00	0.00	0.00	0.00	99.00	99.00
TU131F	1	103	22.48	0.00	0.00	0.00	0.00	0.00	0.00	19.97	19.97
TU13680X	1	124	18.65	0.00	0.00	0.00	0.00	0.00	0.00	21.02	21.02
TU136A	1	101	67.13	0.00	0.00	0.00	0.00	0.00	0.00	4.80	4.80
TU136C	1	101	11.10	0.00	0.00	0.00	0.00	0.00	0.00	25.52	25.52
TU136D	1	101	7.21	0.00	0.00	0.00	0.00	0.00	0.00	52.85	52.85
TU136F	1	101	15.80	0.00	0.00	0.00	0.00	0.00	0.00	22.97	22.97

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for means estimated for the total population

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
I015	11445	38.75	0.00	0.00	0.04	0.14	0.12	0.43	0.33	0.37
I016	11445	160.26	-0.21	-0.13	0.14	0.27	0.22	0.44	0.63	0.68
I089HA	7579	2102.30	7.68	0.36	1.20	0.60	0.87	0.45	1.81	1.45
I089HB	7579	2173.09	40.05	1.84	2.38	0.58	1.50	0.44	2.86	1.41
I0141FA	15089	7039.68	-17.34	-0.24	-0.44	-0.30	-0.44	-0.29	1.08	1.06
I0141FB	15089	8704.41	-38.25	-0.43	-0.57	-0.41	-0.66	-0.53	1.04	0.89

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for means estimated for males

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI $R\sqrt{MSE}$%	NIC $R\sqrt{MSE}$%
IQ15	6062	41.04	-0.01	-0.02	0.04	0.17	0.08	0.36	0.46	0.49
IQ16	6062	183.64	-0.19	-0.10	0.22	0.30	0.25	0.33	0.92	0.98
IQ89HA	3970	2182.70	17.98	0.82	2.10	0.73	1.07	0.46	2.86	1.73
IQ89HB	3970	2304.58	63.71	2.76	3.60	0.74	1.54	0.58	4.29	1.47
IQ141FA	7357	6623.30	-14.53	-0.21	0.02	0.25	0.01	0.18	1.39	1.42
IQ141FB	7357	8214.18	-32.41	-0.39	0.09	0.28	0.07	0.21	1.27	1.32

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for means estimated for individuals of high ability

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
IQ15	2107	36.26	-0.01	-0.02	-0.08	0.05	-0.09	0.05	0.85	0.84
IQ16	2107	148.26	-0.10	-0.06	0.03	0.18	0.02	0.14	1.24	1.31
IQ89HA	2155	2597.94	24.85	0.95	0.91	-0.17	0.47	-0.14	2.12	1.21
IQ89HB	2155	2698.50	51.33	1.90	2.07	0.38	1.00	0.25	2.93	1.51
IQ141FA	2839	5327.10	2.23	0.04	-0.14	0.15	-0.06	0.07	2.08	2.03
IQ141FB	2839	5349.55	-22.50	-0.30	-0.41	-0.29	-0.26	-0.19	1.60	1.56

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for means estimated for individuals of low socio-economic status

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
IQ15	3151	39.46	-0.03	-0.07	0.02	0.20	0.06	0.63	0.30	0.37
IQ16	3151	156.54	-0.20	-0.12	0.25	0.54	0.18	0.37	1.41	1.54
IQ89HA	1420	1638.01	28.40	1.73	3.89	3.49	1.19	1.60	5.08	4.12
IQ89HB	1420	1732.64	30.08	1.73	2.44	1.00	0.64	0.33	4.49	3.15
IQ141FA	4220	7662.68	-19.44	-0.25	-0.70	-0.52	-0.43	-0.39	1.77	1.44
IQ141FB	4220	8966.36	-67.27	-0.75	-1.18	-0.76	-0.75	-0.55	1.95	1.57

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for means estimated for blacks

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
I015	1458	37.68	0.14	0.37	0.49	0.45	0.65	0.62	0.90	0.85
I016	1458	145.73	0.01	0.00	0.54	0.89	0.21	0.34	2.66	2.75
I089HA	928	1702.03	51.43	3.02	4.29	2.27	0.90	0.55	6.42	4.67
I089HB	928	1774.33	30.58	1.72	1.94	-0.92	0.31	-0.25	6.52	3.76
I141FA	1963	5945.88	-55.44	-0.93	-3.02	-1.62	-1.03	-0.50	4.21	3.61
I141FB	1963	6989.57	-65.36	-0.93	-1.80	-0.41	-0.61	-0.13	3.43	3.21

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for means estimated for the South

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RD%	NIC RD%	NI BR	NIC BR	NI RVARSE%	NIC RVARSE%
IQ15	3040	39.06	0.00	0.00	-0.02	0.16	-0.04	0.24	0.59	0.68
IQ16	3040	162.99	-0.42	-0.25	0.09	0.55	0.08	0.46	1.10	1.31
IQ89HA	1922	2127.80	-37.70	-1.77	-0.45	0.45	-0.24	0.22	1.[illegible]	2.07
IQ89HB	1922	2196.52	0.75	0.03	0.65	0.54	0.24	0.22	2.15	2.58
IQ141FA	3948	7352.66	-13.84	-0.18	-0.79	-0.68	-0.70	-0.55	1.38	1.41
IQ141FB	3948	5119.38	-5.02	-0.05	-0.30	-0.39	-0.34	-0.33	1.27	1.21

Comp_.ison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for means estimated for blacks of average ability

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI $R\sqrt{MSE}$%	NIC $R\sqrt{MSE}$%
I015	256	37.11	0.06	0.16	0.66	0.50	0.33	0.25	2.08	2.07
I016	256	162.89	-1.02	-0.62	0.94	1.61	0.11	0.19	7.95	8.26
I089HA	233	1890.48	-12.49	-0.66	-2.03	1.45	-0.32	0.20	6.51	7.22
I089HB	233	1974.43	-19.62	-0.99	-0.27	0.92	-0.03	0.11	7.26	7.83
I0141FA	357	5648.06	39.46	0.69	3.26	4.14	0.45	0.55	7.90	8.51
I0141FB	357	6901.88	-2.92	-0.04	-0.43	1.25	-0.06	0.17	7.01	7.15

Appendix G

COMPARISON OF NO IMPUTATION ESTIMATES WHEN INCONSISTENT DATA ARE REMOVED (NIC) AND WHEN RETAINED (NI) FOR SELECTED CROSS-TABULATIONS

Glossary of Terms Used in the Tables

SAMPLE SIZE - number of sample members eligible to respond to a particular item for the domain under consideration.

$\bar{Y}$-TRUE - the estimate obtained using the telephone corrected and completed data.

NI - estimates obtained using no imputation or editing procedure on the experimental data set.

NIC - estimates obtained using no imputation or editing procedure on the experimental data set after inconsistent data are removed.

ME - measurement error caused by the use of data containing logical inconsistencies.

RB% - the relative bias defined to be the bias divided by the value of $\bar{Y}$-TRUE, expressed as a percentage.

BR - the bias ratio defined as the bias divided by the standard error of the estimate.

$R\sqrt{MSE}\%$ - the relative root mean square error defined as the square root of the mean square error divided by the value of $\bar{Y}$-TRUE and expressed as a percentage.

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for cross-tabulations of the total population

CROSS-TABULATION	SAMPLE SIZE	Y-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
TQ1A x TQ1C	15089	10.21	-1.12	-10.97	-10.81	-9.01	-3.30	-2.64	11.29	9.63
TQ1A x TQ1D	15089	2.97	0.15	5.04	4.71	-7.50	1.03	-1.36	6.55	9.31
TQ9A x TQ9C	15089	17.24	-4.25	-24.65	-24.70	-20.62	-14.76	-13.82	24.76	20.67
TQ9A x TQ9D	15089	2.68	-0.33	-12.32	-11.99	-20.05	-2.74	-5.31	12.76	20.40
TQ131A x TQ131C	6336	5.11	0.00	0.00	0.28	0.52	0.03	0.05	8.80	8.86
TQ131A x TQ131F	6336	10.12	0.02	0.19	0.45	0.43	0.10	0.09	4.37	4.38
TQ136A x TQ136C	5743	5.06	0.00	0.00	0.37	0.39	0.04	0.04	8.04	8.05
TQ136A x TQ136F	5743	7.62	0.01	0.13	-0.48	-0.63	-0.09	-0.13	4.88	4.90

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for cross-tabulations of males

CROSS-TABULATION	SAMPLE SIZE	Y-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
TQ1A x TQ1C	7357	11.69	-1.53	-13.08	-12.96	-9.66	-2.93	-2.15	13.69	10.66
TQ1A x TQ1D	7357	3.64	0.2%	5.49	5.51	-5.31	0.99	-0.96	7.80	7.65
TQ9A x TQ9C	7357	18.45	-4.21	-22.82	-23.13	-20.27	-8.48	-9.56	23.29	20.38
TQ9A x TQ9D	7357	3.46	-0.36	-10.40	-10.05	-16.97	-2.26	-3.07	10.98	17.84
TQ131A x TQ131C	2592	3.69	0.00	0.00	0.25	0.58	0.02	0.05	11.00	11.12
TQ131A x TQ131F	2592	22.90	0.04	0.17	0.30	0.48	0.12	0.19	2.45	2.49
TQ136A x TQ136C	2231	3.78	0.00	0.00	0.62	0.65	0.04	0.05	12.92	12.93
TQ136A x TQ136F	2231	17.86	0.00	0.00	-0.50	-0.47	-0.10	-0.10	4.64	4.63

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for cross-tabulations for individuals of high ability

CROSS-TABULATION	SAMPLE SIZE	Y-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI OR	NIC BR	NI RVMSE%	NIC RVMSE%
TQ1A x TQ1C	2839	16.36	-1.68	-10.27	-10.10	-6.27	-2.25	-1.49	11.06	7.54
TQ1A x TQ1D	2839	2.73	0.02	0.73	0.68	-5.24	0.04	-0.40	13.81	14.01
TQ9A x TQ9C	2839	32.15	-8.43	-26.22	-26.29	-16.47	-12.74	-6.43	26.37	16.67
TQ9A x TQ9D	2839	1.93	-0.24	-12.46	-12.00	-7.85	-0.86	-0.49	18.56	17.65
TQ131A x TQ131C	867	9.52	0.00	0.00	0.21	0.21	0.01	0.01	13.34	13.34
TQ131A x TQ131F	867	12.61	0.00	0.00	0.21	0.21	0.01	0.01	15.30	15.30
TQ136A x TQ136C	731	10.87	0.00	0.00	0.16	0.16	0.01	0.01	13.94	13.94
TQ136A x TQ136F	731	8.01	0.00	0.00	0.16	0.16	0.00	0.00	17.70	17.70

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for cross-tabulations for individuals of low socio-economic status

CROSS-TABULATION	SAMPLE SIZE	Y-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
TQ1A x TQ1C	4220	5.98	-0.87	-14.55	-14.40	-16.02	-1.98	-1.92	16.13	16.05
TQ1A x TQ1D	4220	2.49	0.44	17.70	17.90	-10.04	1.87	-1.06	20.29	13.78
TQ9A x TQ9C	4220	9.28	-2.35	-25.33	-24.96	-24.77	-4.93	-4.84	25.47	25.29
TQ9A x TQ9D	4220	1.96	0.06	3.03	3.68	-18.21	0.51	-2.20	8.07	19.99
TQ131A x TQ131C	2093	3.15	0.00	0.00	0.35	0.74	0.02	0.05	13.69	13.60
TQ131A x TQ131F	2093	8.73	0.09	1.03	1.02	0.37	0.14	0.05	7.18	7.19
TQ136A x TQ136C	2021	3.61	0.00	0.00	0.15	0.23	0.01	0.02	10.60	10.59
TQ136A x TQ136F	2021	6.18	0.05	0.80	0.83	0.23	0.10	0.02	8.29	8.39

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for cross-tabulations for blacks

CROSS-TABULATION	SAMPLE SIZE	Y-TRUE	NE BIAS	NE RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
TQ1A x TQ1C	1963	9.74	-1.20	-12.31	-12.12	-12.01	-1.63	-1.35	14.22	14.91
TQ1A x TQ1D	1963	2.99	-0.19	-6.34	-6.16	-17.46	-0.43	-1.41	15.46	21.40
TQ9A x TQ9C	1963	15.04	-3.90	-25.92	-25.39	-20.65	-3.50	-2.94	26.41	21.81
TQ9A x TQ9D	1963	3.57	-0.45	-12.60	-11.89	-17.33	-0.84	-1.14	18.40	22.97
TQ131A x TQ131C	644	3.99	0.00	0.00	0.99	1.99	0.03	0.07	25.99	26.42
TQ131A x TQ131F	644	9.85	0.16	1.62	1.31	0.70	0.08	0.04	14.79	15.13
TQ136A x TQ136C	615	4.66	0.00	0.00	0.90	1.21	0.04	0.06	19.49	19.54
TQ136A x TQ136F	615	7.29	0.17	2.33	3.20	1.21	0.16	0.06	19.24	19.32

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for cross-tabulations for the South

CROSS-TABULATION	SAMPLE SIZE	Y-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
TQ1A x TQ1C	3948	10.59	-1.30	-12.27	-12.23	-12.41	-1.71	-1.73	14.16	14.33
TQ1A x TQ1D	3948	3.04	0.08	2.63	2.78	-7.87	0.19	-0.53	14.24	16.70
TQ9A x TQ9C	3948	16.58	-4.37	-26.35	-26.43	-22.16	-5.12	-4.03	26.93	22.83
TQ9A x TQ9D	3948	2.81	-0.44	-15.63	-15.54	-25.14	-2.30	-5.13	16.95	25.61
TQ131A x TQ131C	1712	4.93	0.00	0.00	0.40	0.57	0.03	0.04	13.40	13.39
TQ131A x TQ131F	1712	9.91	0.00	0.00	0.40	0.57	0.07	0.10	5.46	5.50
TQ136A x TQ136C	1518	5.99	0.00	0.00	0.57	0.57	0.04	0.04	13.39	13.39
TQ136A x TQ136F	1518	7.45	0.00	0.00	-1.42	-1.42	-0.14	-0.14	9.95	9.95

Comparison of no imputation estimates when inconsistent data are removed (NIC) and when retained (NI) for cross-tabulations for blacks of average ability

CROSS-TABULATION	SAMPLE SIZE	Y-TRUE	ME BIAS	ME RB%	NI RB%	NIC RB%	NI BR	NIC BR	NI RVMSE%	NIC RVMSE%
TQ1A x TQ1C	357	11.93	-1.93	-16.18	-16.17	-15.03	-0.63	-0.57	30.14	30.12
TQ1A x TQ1D	357	3.05	-0.80	-26.24	-26.12	-26.94	-0.96	-0.97	37.63	38.56
TQ9A x TQ9C	357	24.32	-8.10	-33.30	-33.30	-26.91	-2.80	-1.88	35.35	30.48
TQ9A x TQ9D	357	4.70	-0.60	-12.77	-12.63	-7.95	-0.75	-0.42	20.97	20.51
TQ131A x TQ131C	103	2.08	0.00	0.00	0.00	0.00	0.00	0.00	99.13	99.13
TQ131A x TQ131F	103	9.22	0.00	0.00	0.00	0.00	0.00	0.00	28.35	28.35
TQ136A x TQ136C	101	1.59	0.00	0.00	0.00	0.00	0.00	0.00	68.86	68.86
TQ136A x TQ136F	101	5.24	0.00	0.00	0.00	0.00	0.00	0.00	42.41	42.41

Appendix H

COMPARISON OF HOT DECK AND WEIGHTING CLASS ESTIMATES WITH NO IMPUTATION ESTIMATES

Glossary of Terms Used in the Tables

SAMPLE SIZE - number of sample members eligible to respond to a particular item for the domain under consideration.

$\bar{Y}$-TRUE - the estimate obtained using the telephone corrected and completed data.

NI - no imputation--refers to the estimates obtained using no imputation or editing procedure on the experimental data set.

HD - hot deck--refers to the estimates obtained after the experimental data set had missing data and violations of routing patterns corrected using a hot deck procedure.

WC - weighting class--refers to the estimates obtained after the experimental data set had missing data and violations of routing patterns corrected using a weighting class procedure.

RB% - the relative bias--defined to be the ratio of the bias to $\bar{Y}$-TRUE, expressed as a percentage.

BR - the bias ratio or the bias divided by the standard error of the estimate.

R$\sqrt{\text{MSE}}$% - the relative root mean square error--defined to be the square root of the mean square error divided by the value of Y-TRUE, expressed as a percentage.

Comparison of hot deck and weighting class estimates with no imputation estimates of proportions for the total population

ITEM	RESPONSE	SAMPLE SIZE	P-TRUE	NI RBX	HD RBX	WC RBX	NI BR	HD BR	WC BR	NI RVHSEX	HD RVHSEX	WC RVHSEX
T 1A	1	15089	72.29	-2.38	-2.40	-2.52	-4.21	-4.30	-4.26	2.45	2.47	2.54
TQ1C	1	15089	17.16	-0.31	-0.27	0.36	-0.14	-0.12	0.16	2.21	2.18	2.25
TQ1D	1	15089	4.12	7.06	7.03	6.91	1.67	1.64	1.64	8.23	8.22	8.09
TQ1G	1	15089	9.19	-13.67	-13.68	-13.79	-5.06	-5.08	-5.14	13.93	13.90	14.05
TQ9A	1	15089	67.82	-6.69	-6.68	-6.80	-9.05	-9.14	-9.08	6.73	6.71	6.83
TQ9C	1	15089	32.15	-1.63	-1.60	-1.14	-1.03	-1.02	-0.72	2.27	2.24	1.95
TQ9D	1	15089	3.96	0.53	0.40	2.35	0.11	0.08	0.51	4.67	4.68	5.17
TQ9G	1	15089	7.00	-22.54	-22.81	-22.45	-5.21	-5.26	-5.32	22.96	23.21	22.84
TQ10	1	15089	61.22	0.09	0.02	-0.12	0.10	0.03	-0.14	0.87	0.87	0.91
TQ10	2	15089	13.06	-0 24	-0.01	1.80	-0.09	0.00	0.62	2.66	2.73	3.40
TQ10	3	15089	1.45	-5.97	-6.76	-6.61	-0.77	-0.86	-0.86	9.76	10.36	10.07
TQ10	4	15089	24.27	0.26	0.34	-0.25	0.16	0.20	-0.15	1.62	1.71	1.62
TQ12	1	3644	25.66	5.03	3.27	2.18	1.41	0.84	0.65	6.16	5.07	4.00
TQ12	2	3644	7.20	0.52	0.42	8.33	0.07	0.05	1.33	7.05	8.45	10.41
TQ12	3	3644	67.14	-1.98	-1.29	-1.73	-1.18	-0.74	-1.06	2.59	2.16	2.37
TQ29	1	11439	91.40	0.03	0.09	-0.58	0.09	0.23	-1.13	0.39	0.39	0.77
TQ29	2	11439	8.60	-0.39	-0.96	6.19	-0.09	-0.23	1.13	4.22	4.14	8.26
TQ33	1	4234	17.56	6.79	3.38	4.51	1.51	0.73	0.97	8.14	5.70	6.46
TQ33	2	4234	3.57	9.81	1.02	7.66	1.33	0.12	0.93	12.26	8.12	11.24
TQ33	3	4234	78.87	-1.95	-0.80	-1.35	-1.90	-0.67	-1.14	2.20	1.43	1.79
TQ51	1	15089	47.13	0.48	0.69	0.72	0.36	0.52	0.56	1.40	1.50	1.48
TQ51	2	15089	52.87	-0.43	-0.62	-0.64	-0.36	-0.52	-0.56	1.25	1.34	1.32
TQ52	1	7579	49.75	0.61	-0.30	-0.08	0.45	-0.28	-0.06	1.47	1.14	1.25
TQ52	2	7579	50.25	-0.60	0.30	0.08	-0.45	0.28	0.06	1.46	1.13	1.24
TQ66	1	7579	20.29	1.32	-0.29	-0.46	0.77	-0.14	-0.21	2.18	1.98	2.18
TQ66	2	7579	32.03	4.15	5.16	5.02	2.32	3.25	2.99	4.52	5.39	5.29
TQ66	3	7579	47.68	-3.35	-3.34	-3.17	-2.26	-2.48	-2.04	3.66	3.60	3.53
TQ90	1	7579	65.64	0.19	-0.48	-0.83	0.16	-0.41	-0.66	1.16	1.28	1.50
TQ90	2	7579	4.67	5.73	6.67	12.35	0.77	0.98	1.52	9.33	9.51	14.71
TQ90	3	7579	5.79	0.93	2.55	1.24	0.14	0.38	0.15	6.59	7.08	8.25
TQ90	4	7579	23.90	-1.87	-0.58	-0.42	-0.52	-0.16	-0.12	4.03	3.62	3.48
TQ101	1	15089	84.17	-0.12	-0.03	-0.28	-0.30	-0.07	-0.74	0.42	0.41	0.48
TQ101	2	15089	15.83	0.66	0.16	1.52	0.30	0.07	0.74	2.26	2.20	2.55
TQ102	1	2199	66.64	-0.46	0.44	0.51	-0.23	0.21	0.25	2.04	2.10	2.05
TQ102	2	2199	33.36	0.92	-0.89	-1.02	0.23	-0.21	-0.25	4.09	4.20	4.09
TQ118	1	15089	92.68	-0.09	-0.01	-0.28	-0.42	-0.05	-0.96	0.25	0.25	0.41
TQ118	2	15089	0.90	1.98	0.23	14.75	0.19	0.02	1.29	10.33	10.57	18.65
TQ118	3	15089	6.42	1.16	0.17	2.10	0.29	0.04	0.46	4.06	3.90	4.95
TQ129	1	15089	9.78	-0.17	0.14	0.31	-0.04	0.03	0.07	3.92	3.94	3.95
TQ129	2	15089	45.95	-0.06	-0.06	-0.07	-0.07	-0.06	-0.08	0.91	0.91	0.91
TQ129	3	15089	4.02	0.07	-0.21	0.60	0.01	-0.04	0.11	5.08	5.11	5.17
TQ129	4	15089	40.25	0.10	0.05	-0.05	0.15	0.07	-0.07	0.70	0.71	0.69
TQ131A	1	6336	73.00	0.07	0.05	-0.19	0.08	0.05	-0.21	0.91	0.95	0.96
TQ131C	1	6336	7.87	-0.03	0.01	2.40	0.00	0.00	0.34	6.38	6.42	7.43
TQ131D	1	6336	4.30	0.08	0.56	3.73	0.00	0.04	0.31	11.53	11.61	12.55
TQ131F	1	6336	26.45	0.16	0.04	0.45	0.04	0.01	0.12	3.38	3.43	3.52
TQ136BOX	1	7010	18.19	0.00	-0.16	0.81	0.00	-0.04	0.22	3.45	3.49	3.65
TQ136A	1	5743	71.91	0.00	-0.03	-0.27	0.00	-0.03	-0.26	1.06	1.11	1.07
TQ136C	1	5743	9.09	0.37	0.29	1.87	0.06	0.05	0.29	5.71	5.65	6.69
TQ136D	1	5743	3.89	-0.19	-0.03	4.60	-0.02	0.00	0.54	7.76	7.92	9.66
TQ136F	1	5743	21.81	-0.39	-0.10	0.62	-0.11	-0.03	0.18	3.52	3.39	3.44

Comparison of hot deck and weighting class estimates with no imputation estimates of proportions for males

ITEM	RESPONSE	SAMPLE SIZE	P-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TQ1A	1	7357	77.00	-3.28	-3.30	-3.40	-5.38	-5.52	-5.27	3.35	3.35	3.47
TQ1C	1	7357	19.84	-0.55	-0.44	-0.01	-0.17	-0.14	0.00	3.21	3.14	3.04
TQ1D	1	7357	4.63	12.34	12.39	12.19	2.67	2.68	2.63	13.17	13.23	13.03
TQ1G	1	7357	9.28	-9.88	-9.70	-10.00	-1.84	-1.81	-1.87	11.24	11.07	11.33
TQ9A	1	7357	71.16	-6.34	-6.34	-6.43	-5.21	-5.16	-5.45	6.46	6.46	6.53
TQ9C	1	7357	35.17	-1.34	-1.24	-0.90	-0.59	-0.54	-0.40	2.63	2.60	2.44
TQ9D	1	7357	4.50	1.89	1.63	3.00	0.52	0.46	0.82	4.09	3.88	4.72
TQ9G	1	7357	7.12	-19.83	-20.04	-20.04	-3.63	-3.63	-3.62	20.56	20.78	20.79
TQ10	1	7357	68.57	0.00	-0.01	-0.12	0.00	-0.01	-0.17	0.72	0.74	0.76
TQ10	2	7357	11.75	-0.67	-0.54	1.14	-0.15	-0.12	0.26	4.35	4.37	4.41
TQ10	3	7357	1.39	-1.67	-2.38	-2.38	-0.12	-0.17	-0.17	13.54	13.86	13.88
TQ10	4	7357	18.28	0.55	0.58	-0.07	0.22	0.22	-0.02	2.59	2.66	2.46
TQ12	1	1295	36.19	1.93	0.58	-0.41	0.44	0.12	-0.09	4.77	4.54	4.20
TQ12	2	1295	6.98	2.14	4.71	9.36	0.25	0.50	1.00	8.58	10.46	13.18
TQ12	3	1295	56.83	-1.49	-0.94	-0.88	-0.49	-0.28	-0.28	3.37	3.44	3.21
TQ29	1	6058	90.26	0.08	0.09	-0.51	0.23	0.27	-0.96	0.36	0.36	0.74
TQ29	2	6058	9.74	-0.77	-0.91	4.81	-0.23	-0.27	0.96	3.36	3.42	6.94
TQ33	1	1633	21.65	7.50	4.22	4.21	1.47	0.70	0.74	9.07	7.29	7.06
TQ33	2	1633	3.90	5.44	-0.93	3.65	0.34	-0.07	0.31	16.86	12.56	12.17
TQ33	3	1633	74.45	-2.46	-1.17	-1.41	-1.44	-0.57	-0.73	3.00	2.36	2.58
TQ51	1	7357	43.76	0.53	0.74	0.89	0.27	0.37	0.48	1.97	2.12	2.04
TQ51	2	7357	56.24	-0.41	-0.58	-0.69	-0.27	-0.37	-0.48	1.54	1.65	1.59
TQ52	1	3970	45.84	0.50	-0.04	0.00	0.24	-0.02	0.00	2.16	2.18	2.53
TQ52	2	3970	54.16	-0.43	0.04	0.00	-0.24	0.02	0.00	1.82	1.88	2.38
TQ66	1	3970	18.94	1.97	-0.72	-0.76	0.77	-0.29	-0.26	3.23	2.53	3.03
TQ66	2	3970	35.38	3.95	4.31	4.39	1.61	1.85	1.86	4.65	4.90	4.98
TQ66	3	3970	45.68	-3.88	-3.04	-3.08	-1.69	-1.46	-1.38	4.51	3.68	3.80
TQ90	1	3970	66.03	0.32	-0.42	-0.65	0.29	-0.23	-0.43	1.16	1.84	1.63
TQ90	2	3970	4.64	6.28	5.44	9.45	0.48	0.41	0.59	14.36	14.31	18.42
TQ90	3	3970	5.32	-0.61	-0.63	0.46	-0.06	-0.06	0.04	9.72	10.24	10.94
TQ90	4	3970	24.11	-1.97	0.24	-0.12	-0.60	0.05	-0.03	3.83	4.14	3.57
TQ101	1	7357	84.87	-0.08	0.05	-0.28	-0.10	0.07	-0.35	0.77	0.80	0.84
TQ101	2	7357	15.13	0.46	-0.32	1.59	0.10	-0.07	0.35	4.36	4.49	4.73
TQ102	1	1031	61.36	-0.30	0.48	0.59	-0.08	0.12	0.15	3.64	3.96	3.81
TQ102	2	1031	38.64	0.48	-0.77	-0.94	0.08	-0.12	-0.15	5.77	6.30	6.06
TQ118	1	7357	87.00	-0.03	0.00	0.23	-0.08	0.01	-0.47	0.42	0.45	0.54
TQ118	2	7357	1.56	-0.68	-1.02	7.86	-0.05	-0.10	0.55	12.61	13.09	16.25
TQ118	3	7357	11.44	0.35	0.15	0.68	0.09	0.03	0.16	3.97	4.04	4.22
TQ129	1	7357	9.93	-0.32	-0.21	-0.11	-0.06	-0.04	-0.02	5.25	5.26	5.29
TQ129	2	7357	54.44	0.02	0.09	-0.05	0.01	0.05	-0.03	1.70	1.70	1.71
TQ129	3	7357	2.87	-0.18	-0.09	1.33	-0.02	-0.01	0.20	6.67	6.85	6.80
TQ129	4	7357	32.81	0.07	-0.08	0.01	0.03	-0.04	0.00	2.02	2.01	2.01
TQ131A	1	2592	95.12	-0.04	-0.04	-0.30	-0.02	-0.02	-0.19	1.64	1.67	1.59
TQ131C	1	2592	7.41	0.25	0.08	3.42	0.02	0.01	0.34	8.66	8.70	10.49
TQ131D	1	2592	2.50	0.25	0.08	1.98	0.01	0.00	0.08	23.40	25.14	22.75
TQ131F	1	2592	62.05	0.03	0.11	-0.12	0.02	0.07	-0.08	1.43	1.53	1.50
TQ136BOX	1	2817	20.73	0.00	0.06	1.18	0.00	0.01	0.30	3.58	3.57	4.04
TQ136A	1	2231	54.83	-0.03	0.00	0.17	-0.01	0.00	0.08	2.00	2.15	1.96
TQ136C	1	2231	8.72	0.62	0.10	2.92	0.08	0.01	0.34	7.44	7.17	8.92
TQ136D	1	2231	2.32	0.02	0.10	7.08	0.03	0.00	0.36	18.75	18.69	20.86
TQ136F	1	2231	53.44	-0.24	0.02	0.03	-0.10	0.00	0.01	2.28	2.34	2.26

Comparison of hot deck and weighting class estimates with no imputation estimates of proportions for individuals of high ability

ITEM	RESPONSE	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI $\sqrt{MSE}$%	HD $\sqrt{MSE}$%	WC $\sqrt{MSE}$%
TQ1A	1	2839	71,74	-4,23	-4,17	-4,36	-3,01	-3,00	-3,04	4,46	4,39	4,59
TQ1C	1	2839	26,28	0,03	0,22	0,42	0,00	0,06	0,11	3,49	3,48	3,57
TQ1D	1	2839	4,11	1,55	1,39	1,39	0,15	0,14	0,14	9,92	9,86	9,86
TQ1G	1	2839	8,38	-11,42	-11,54	-11,54	-2,02	-2,05	-2,05	12,74	12,84	12,84
TQ9A	1	2839	63,08	-14,60	-14,63	-14,57	-10,55	-10,37	-10,34	14,67	14,69	14,64
TQ9C	1	2839	58,79	-0,73	-0,74	-0,60	-0,39	-0,38	-0,32	2,01	2,07	1,98
TQ9D	1	2839	2,86	0,38	0,20	3,61	0,02	0,01	0,25	13,60	13,56	14,37
TQ9G	1	2839	4,91	-33,39	-33,51	-33,51	-3,50	-3,50	-3,62	34,72	34,85	34,76
TQ10	1	2839	53,65	-0,30	-0,52	-0,55	-0,13	-0,24	-0,23	2,21	2,25	2,37
TQ10	2	2839	20,40	-0,52	0,61	0,52	-0,18	0,20	0,17	2,84	3,05	3,00
TQ10	3	2839	1,26	-2,35	-2,82	-2,82	-0,11	-0,13	-0,13	20,94	20,85	20,85
TQ10	4	2839	24,70	1,21	0,77	0,90	0,27	0,17	0,20	4,58	4,43	4,51
TQ12	1	732	22,03	4,96	0,60	1,91	0,64	0,07	0,25	9,14	8,26	7,68
TQ12	2	732	6,26	1,47	1,65	8,03	0,08	0,08	0,48	17,27	20,42	18,41
TQ12	3	732	71,72	-1,65	-0,33	-1,28	-0,60	-0,10	-0,45	3,18	3,17	3,11
TQ29	1	2107	89,82	-0,03	-0,05	-0,36	-0,04	-0,07	-0,43	0,77	0,76	0,89
TQ29	2	2107	10,18	0,32	0,49	3,17	0,04	0,07	0,43	6,86	6,74	7,91
TQ33	1	993	9,39	17,65	11,02	11,49	1,29	0,78	0,84	22,57	17,81	17,80
TQ33	2	993	2,35	7,94	0,00	9,71	0,53	0,00	0,58	16,80	13,50	19,14
TQ33	3	993	88,26	-2,11	-1,17	-1,48	-1,42	-0,77	-0,96	2,57	1,91	2,13
TQ51	1	2839	21,90	1,49	1,31	1,70	0,36	0,33	0,41	4,34	4,17	4,40
TQ51	2	2839	78,10	-0,41	-0,36	-0,47	-0,36	-0,33	-0,41	1,21	1,17	1,23
TQ52	1	2155	47,38	-0,07	0,34	-0,19	-0,03	0,11	-0,06	2,20	2,99	3,03
TQ52	2	2155	52,62	0,06	-0,31	0,17	0,03	-0,11	0,06	1,98	2,69	2,73
TQ66	1	2155	11,65	-2,60	-3,32	-2,47	-0,43	-0,50	-0,36	6,50	7,37	7,30
TQ66	2	2155	32,40	3,77	3,85	3,23	1,04	0,96	0,84	5,21	4,96	5,03
TQ66	3	2155	55,95	-1,64	-1,30	-1,35	-0,90	-0,60	-0,63	2,44	2,53	2,58
TQ90	1	2155	62,00	-0,07	-0,47	-0,44	-0,04	-0,31	-0,24	1,84	1,57	1,85
TQ90	2	2155	5,15	2,49	4,07	7,68	0,13	0,23	0,48	18,60	18,10	17,53
TQ90	3	2155	5,26	-0,16	-1,01	-1,41	-0,01	-0,10	-0,12	12,30	9,70	11,18
TQ90	4	2155	27,59	-0,26	0,50	-0,16	-0,05	0,10	-0,04	4,62	4,67	4,01
TQ101	1	2839	64,32	0,05	0,13	-0,02	0,02	0,06	-0,01	2,05	2,04	2,07
TQ101	2	2839	35,68	-0,09	-0,24	0,04	-0,02	-0,06	0,01	3,71	3,68	3,73
TQ102	1	951	60,71	0,25	0,24	0,55	0,14	0,13	0,28	1,78	1,91	2,05
TQ102	2	951	39,29	-0,39	-0,38	-0,85	-0,14	-0,13	-0,28	2,76	2,95	3,17
TQ118	1	2839	94,43	-0,02	-0,02	-0,03	-0,05	-0,06	-0,05	0,42	0,42	0,56
TQ118	2	2839	0,41	-13,67	-14,98	-3,05	-0,60	-0,66	-0,06	26,50	26,93	45,88
TQ118	3	2839	5,17	1,53	1,67	0,81	0,20	0,22	0,08	7,58	7,68	9,20
TQ129	1	2839	10,73	0,05	-0,29	0,19	0,00	-0,04	0,02	6,75	6,67	6,84
TQ129	2	2839	58,04	-0,08	0,03	-0,09	-0,04	0,02	-0,05	1,78	1,75	1,79
TQ129	3	2839	2,37	0,33	0,00	0,00	0,02	0,00	0,00	11,83	11,80	12,26
TQ129	4	2839	28,86	0,11	0,03	0,11	0,03	0,01	0,03	3,28	3,23	3,30
TQ131A	1	867	78,46	-0,05	0,01	-0,38	-0,02	0,00	-0,17	2,12	2,11	2,18
TQ131C	1	867	12,63	0,21	-0,03	1,88	0,02	0,00	0,18	10,32	10,33	10,16
TQ131D	1	867	4,61	0,21	-0,03	6,97	0,00	0,00	0,29	22,54	22,40	24,78
TQ131F	1	867	22,94	0,21	-0,03	0,21	0,01	0,00	0,01	11,15	11,04	11,25
TQ136BOX	1	940	22,20	0,00	-0,34	-0,10	0,00	-0,04	-0,01	6,99	6,89	6,56
TQ136A	1	731	72,05	-0,06	0,05	-0,36	-0,01	0,01	-0,10	3,40	3,35	3,47
TQ136C	1	731	17,65	0,16	-0,13	1,56	0,01	-0,01	0,15	9,61	9,47	10,24
TQ136D	1	731	4,05	0,16	-0,13	7,26	0,00	0,00	0,28	26,85	26,73	26,26
TQ136F	1	731	17,55	0,16	-0,13	-0,13	0,01	-0,01	-0,01	11,34	11,17	11,20

Comparison of hot deck and weighting class estimates with no imputation estimates of proportions for individuals of low socio-economic status

ITEM	RESPONSE	SAMPLE SIZE	Y-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RMSE%	HD RMSE%	WC RMSE%
TQ1A	1	4220	69,91	-1,47	-1,51	-1,54	-1,24	-1,26	-1,34	1,89	1,93	1,93
TQ1C	1	4220	10,77	-0,50	-0,36	0,11	-0,07	-0,05	0,01	6,68	6,66	6,75
TQ1D	1	4220	3,84	11,04	10,95	10,95	1,29	1,24	1,28	13,95	14,05	13,89
TQ1G	1	4220	11,47	-12,77	-12,83	-12,83	-2,92	-2,93	-2,93	13,49	13,56	13,56
TQ9A	1	4220	68,85	-3,46	-3,46	-3,67	-2,59	-2,55	-2,89	3,71	3,72	3,88
TQ9C	1	4220	16,26	-4,46	-3,87	-3,08	-0,71	-0,61	-0,48	7,70	7,40	7,05
TQ9D	1	4220	3,66	6,66	7,15	9,37	0,89	0,93	1,18	10,01	10,45	12,25
TQ9G	1	4220	10,13	-19,92	-20,26	-19,92	-2,75	-2,81	-2,79	21,20	21,51	21,16
TQ10	1	4220	62,88	-0,13	-0,38	-0,38	-0,09	-0,26	-0,29	1,33	1,50	1,56
TQ10	2	4220	9,10	1,03	2,36	5,10	0,23	0,48	1,02	4,49	5,43	7,13
TQ10	3	4220	1,93	4,17	2,92	2,92	0,36	0,25	0,25	12,31	11,96	11,82
TQ10	4	4220	26,09	-0,35	-0,11	-1,07	-0,11	-0,03	-0,34	3,09	3,16	3,26
TQ12	1	1069	30,32	4,32	1,46	1,85	1,22	0,43	0,56	5,58	3,70	3,77
TQ12	2	1069	7,30	-0,73	-0,41	3,96	-0,06	-0,03	0,30	11,39	12,91	13,78
TQ12	3	1069	62,39	-2,01	-0,66	-1,36	-1,01	-0,33	-0,70	2,83	2,05	2,56
TQ29	1	3150	91,46	0,00	0,16	-0,51	-0,01	0,27	-0,58	0,54	0,61	1,02
TQ29	2	3150	8,54	0,09	-1,77	5,51	0,01	-0,27	0,58	5,81	6,62	10,95
TQ33	1	1099	26,92	3,71	1,86	2,29	1,06	0,59	0,64	5,08	3,66	4,24
TQ33	2	1099	3,71	10,93	1,31	7,64	0,96	0,08	0,37	15,71	14,85	21,59
TQ33	3	1099	69,38	-2,02	-0,79	-1,29	-1,37	-0,48	-0,78	2,50	1,80	2,10
TQ51	1	4220	64,83	0,04	0,28	-0,13	0,03	0,17	-0,10	1,57	1,69	1,38
TQ51	2	4220	35,17	-0,09	-0,52	0,25	-0,03	-0,17	0,10	2,90	3,13	2,55
TQ52	1	1420	49,78	1,20	-1,75	-2,04	0,33	-0,45	-0,46	3,81	4,23	4,89
TQ52	2	1420	50,22	-1,19	1,75	2,03	-0,33	0,45	0,46	3,77	4,19	4,85
TQ66	1	1420	30,72	2,34	-2,26	-2,99	0,48	-0,46	-0,64	5,36	5,34	5,51
TQ66	2	1420	29,91	3,43	9,82	9,16	0,71	1,80	1,86	5,89	11,23	10,40
TQ66	3	1420	39,37	-4,43	-5,69	-4,62	-1,09	-1,44	-1,17	5,99	6,92	6,07
TQ90	1	1420	52,38	-0,01	0,49	-0,14	0,00	0,10	-0,02	4,41	4,77	5,05
TQ90	2	1420	6,44	6,94	9,89	18,28	0,57	0,72	1,18	13,88	16,85	23,94
TQ90	3	1420	8,32	2,52	-5,06	-6,85	0,40	-0,54	-0,46	6,77	10,61	16,40
TQ90	4	1420	32,86	-1,97	-1,48	-1,61	-0,33	-0,28	-0,30	6,17	5,24	5,55
TQ101	1	4220	94,03	-0,02	0,06	-0,24	-0,04	0,10	-0,46	0,56	0,57	0,58
TQ101	2	4220	5,97	0,36	-0,97	3,87	0,04	-0,10	0,46	8,94	9,02	9,25
TQ102	1	230	67,12	-1,02	0,98	2,64	-0,14	0,13	0,38	7,36	7,40	7,42
TQ102	2	230	32,88	2,10	-2,00	-5,40	0,14	-0,13	-0,38	15,02	15,12	15,14
TQ118	1	4220	90,23	-0,14	-0,02	-0,25	-0,23	-0,04	-0,33	0,65	0,60	0,79
TQ118	2	4220	1,43	3,51	0,00	8,68	0,18	0,00	0,38	19,74	18,90	24,22
TQ118	3	4220	8,33	-0,94	0,30	1,22	0,13	0,04	0,15	7,28	7,37	7,97
TQ129	1	4220	9,35	-0,37	0,44	-0,16	-0,05	0,06	-0,02	7,31	7,43	7,95
TQ129	2	4220	35,96	-0,17	0,07	0,32	-0,08	0,03	0,14	2,19	2,31	2,26
TQ129	3	4220	6,12	-0,29	-0,57	-0,77	-0,03	-0,06	-0,08	9,05	9,08	9,47
TQ129	4	4220	48,57	0,24	-0,07	-0,11	0,15	-0,04	-0,07	1,56	1,53	1,49
TQ131A	1	2093	71,01	0,19	0,28	-0,17	0,09	0,13	-0,08	2,05	2,14	2,13
TQ131C	1	2093	5,12	-1,34	-1,62	5,07	-0,08	-0,10	0,27	15,50	15,61	19,44
TQ131D	1	2093	3,97	-0,38	-0,20	8,00	-0,03	-0,01	0,55	11,74	11,68	16,43
TQ131F	1	2093	26,91	0,10	0,05	0,63	0,02	0,01	0,12	5,07	5,22	5,20
TQ136BOX	1	2354	14,14	0,00	0,10	1,23	0,00	0,01	0,19	6,99	7,31	6,60
TQ136A	1	2021	71,81	-0,06	-0,18	-0,44	-0,03	-0,11	-0,29	1,59	1,60	1,57
TQ136C	1	2021	5,72	0,15	0,14	1,65	0,01	0,01	0,15	10,14	10,49	10,89
TQ136D	1	2021	3,65	-1,73	-1,74	4,67	-0,17	-0,17	0,41	10,18	10,15	12,18
TQ136F	1	2021	21,46	0,35	0,28	0,57	0,06	0,05	0,10	5,21	5,32	5,34

Comparison of hot deck and weighting class estimates with no imputation estimates of proportions for blacks

ITEM	RESPONSE	SAMPLE SIZE	Y-TRUE	NI RBX	HD RBX	WC RBX	NI BR	HD BR	WC BR	NI RVMSEX	HD RVMSEX	WC RVMSEX
TQ1A	1	1963	69,37	-1,98	-1,97	-2,17	-1,00	-0,98	-1,11	2,81	2,82	2,91
TQ1C	1	1963	17,03	-1,83	-1,67	-0,92	-0,35	-0,32	-0,17	5,40	5,44	5,25
TQ1D	1	1963	5,51	-2,38	-1,65	-2,56	-0,19	-0,12	-0,21	12,31	12,87	12,35
TQ1G	1	1963	14,45	-16,94	-17,10	-17,10	-2,10	-2,12	-2,12	18,76	18,90	18,90
TQ9A	1	1963	64,93	-4,44	-4,42	-4,77	-2,13	-2,05	-2,34	4,90	4,91	5,19
TQ9C	1	1963	26,71	-5,16	-5,62	-4,21	-0,77	-0,86	-0,60	8,43	8,61	8,16
TQ9D	1	1963	6,83	2,80	-3,38	3,73	0,27	0,31	0,34	10,52	11,32	11,35
TQ9G	1	1963	13,81	-25,26	-25,79	-24,97	-3,31	-3,38	-3,13	26,38	26,89	26,21
TQ10	1	1963	59,55	0,89	0,29	0,48	0,43	0,13	0,21	2,26	2,29	2,24
TQ10	2	1963	12,36	-1,14	-0,05	4,04	-0,19	0,00	0,78	5,87	6,59	6,55
TQ10	3	1963	1,85	8,29	5,54	5,54	0,29	0,19	0,20	29,68	29,32	27,32
TQ10	4	1963	26,24	-2,08	-1,04	-3,39	-0,46	-0,23	-0,78	4,97	4,56	5,51
TQ12	1	505	38,87	4,59	2,50	-0,29	0,64	0,32	-0,03	8,47	8,05	7,40
TQ12	2	505	12,45	-0,61	2,45	5,72	-0,03	0,15	0,35	16,04	16,03	16,92
TQ12	3	505	48,68	-3,51	-2,62	-1,22	-0,64	-0,52	-0,22	6,47	5,69	5,58
TQ29	1	1455	92,03	-0,05	-0,04	-0,71	-0,06	-0,02	-0,42	0,88	1,50	1,80
TQ29	2	1455	7,97	0,62	0,47	8,21	0,06	0,02	0,42	10,18	17,43	20,86
TQ33	1	569	37,85	1,14	0,49	-0,03	0,22	0,11	0,00	5,14	4,52	4,52
TQ33	2	569	5,80	20,90	1,94	13,09	0,82	0,15	0,96	32,77	12,57	18,88
TQ33	3	569	56,35	-2,92	-0,53	-1,32	-0,95	-0,17	-0,44	4,23	3,05	3,26
TQ51	1	1963	50,21	-0,11	0,27	0,56	-0,09	0,07	0,17	3,26	3,42	3,26
TQ51	2	1963	49,79	0,11	-0,27	-0,56	0,03	-0,07	-0,17	3,29	3,45	3,24
TQ52	1	928	44,94	4,01	1,40	2,35	0,94	0,27	0,43	5,85	5,32	5,91
TQ52	2	928	55,06	-3,27	-1,14	-1,92	-0,94	-0,27	-0,43	4,78	4,34	4,82
TQ66	1	928	23,08	8,01	-0,52	0,97	1,05	-0,05	0,10	11,05	9,06	8,98
TQ66	2	928	35,77	2,31	8,72	5,73	0,42	1,51	1,22	5,94	10,46	7,41
TQ66	3	928	41,15	-6,50	-7,29	-5,53	-1,65	-1,66	-1,05	7,60	8,50	7,61
TQ90	1	928	42,92	-0,10	0,50	-3,61	-0,02	0,09	-0,80	4,36	5,09	5,75
TQ90	2	928	6,37	30,06	25,69	36,39	1,43	0,98	1,72	36,69	36,67	42,05
TQ90	3	928	10,97	-0,72	-3,06	0,22	-0,06	-0,21	0,01	12,04	14,58	13,88
TQ90	4	928	39,75	-4,50	-3,81	-1,98	-0,67	-0,58	-0,30	8,04	7,60	6,79
TQ101	1	1963	90,16	-0,30	-0,24	-0,77	-0,27	-0,21	-0,67	1,14	1,14	1,38
TQ101	2	1963	9,84	2,81	2,26	7,11	0,27	0,21	0,67	10,51	10,53	12,69
TQ102	1	180	64,15	-1,97	1,23	1,84	-0,31	0,16	0,23	6,50	7,39	8,13
TQ102	2	180	35,85	3,53	-2,21	-3,30	0,31	-0,16	-0,23	11,64	13,24	14,55
TQ118	1	1963	89,04	-0,35	0,20	-0,57	-0,32	0,17	-0,48	1,13	1,17	1,32
TQ118	2	1963	1,24	1,25	-4,12	21,72	0,04	-0,15	0,68	28,14	27,54	38,49
TQ118	3	1963	9,72	3,07	-1,31	2,53	0,32	-0,13	0,24	9,83	9,90	10,5
TQ129	1	1963	12,11	-0,21	2,91	0,89	-0,02	0,31	0,09	8,80	9,62	9,70
TQ129	2	1963	51,15	0,02	-0,59	-0,24	0,00	-0,21	-0,10	2,29	2,82	2,22
TQ129	3	1963	4,24	1,72	1,95	4,03	0,14	0,16	0,32	11,68	11,70	13,14
TQ129	4	1963	32,50	-0,17	-0,40	-0,48	-0,04	-0,09	-0,11	4,25	4,51	4,32
TQ131A	1	644	73,54	-0,03	0,17	-0,52	0,00	0,04	-0,12	3,88	3,71	4,11
TQ131C	1	644	6,67	0,99	0,41	10,99	0,05	0,02	0,68	16,82	17,83	19,43
TQ131D	1	644	4,02	-1,84	8,78	10,39	-0,07	0,31	0,42	25,63	25,51	26,43
TQ131F	1	644	24,42	1,55	2,22	3,78	0,15	0,23	0,38	10,10	9,59	10,41
TQ1368X	1	745	17,27	0,00	0,89	4,57	0,00	0,13	0,60	6,71	6,90	8,82
TQ136A	1	615	73,44	0,25	-0,92	-0,80	0,11	-0,40	-0,34	2,23	2,43	2,43
TQ136C	1	615	8,54	0,90	0,32	11,96	0,06	0,02	0,56	14,25	12,94	24,21
TQ136D	1	615	4,78	-1,64	0,52	1,54	-0,08	0,02	0,07	18,48	18,64	20,48
TQ136F	1	615	18,05	-0,55	3,63	2,01	-0,06	0,39	0,20	9,12	9,97	10,04

Comparison of hot deck and weighting class estimates with no imputation estimates of proportions for the South

ITEM	RESPONSE	SAMPLE SIZE	Ȳ-TRUE	NI %RB%	HD RB%	WC RB%	NI BR	HD BR	WC %BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TQ1A	1	3948	73,45	-2,87	-2,95	-3,00	-3,13	-3,23	-3,13	3,01	3,09	3,15
TQ1C	1	3948	17,20	1,50	1,36	2,15	0,28	0,26	0,39	5,43	5,35	5,83
TQ1D	1	3948	4,21	2,88	2,74	2,74	0,36	0,35	0,35	8,33	8,26	8,24
TQ1G	1	3948	8,07	-11,97	-11,50	-12,09	-2,33	-2,22	-2,35	13,03	12,61	13,14
TQ9A	1	3948	68,68	-7,09	-7,01	-7,27	-8,57	-8,70	-8,87	7,13	7,06	7,31
TQ9C	1	3948	30,59	-0,89	-0,81	-0,45	-0,30	-0,27	-0,15	3,06	3,05	2,94
TQ9D	1	3948	4,04	-4,78	-4,78	-4,78	-0,59	-0,62	-0,62	8,98	9,02	9,02
TQ9G	1	3948	7,28	-22,17	-22,33	-22,33	-6,24	-6,37	-6,37	22,46	22,60	22,60
TQ10	1	3948	61,38	0,26	0,29	0,20	0,29	0,32	0,20	0,94	0,95	0,99
TQ10	2	3948	14,20	0,23	0,47	1,09	0,05	0,11	0,24	4,16	3,98	4,49
TQ10	3	3948	1,35	-10,81	-11,31	-11,31	-1,05	-1,03	-1,11	14,88	15,76	15,21
TQ10	4	3948	23,07	-0,22	-0,42	-0,54	-0,09	-0,16	-0,21	2,55	2,55	2,62
TQ12	1	908	22,91	8,44	6,16	5,37	1,24	0,87	0,68	10,83	9,38	9,52
TQ12	2	908	7,94	-0,99	-0,86	4,92	-0,09	-0,08	0,41	10,33	10,27	12,73
TQ12	3	908	69,16	-2,68	-1,94	-2,34	-1,17	-0,85	-1,01	3,52	2,98	3,28
TQ29	1	3039	90,75	0,02	0,06	-0,64	0,03	0,09	-1,02	0,74	0,67	0,90
TQ29	2	3039	9,25	-0,22	-0,62	6,33	-0,03	-0,09	1,02	7,28	6,65	8,86
TQ33	1	1088	18,26	7,39	5,99	6,98	0,85	0,78	0,87	11,41	9,75	10,58
TQ33	2	1088	3,66	6,53	-3,58	5,76	0,75	-0,34	0,46	10,84	11,05	15,68
TQ33	3	1088	78,09	-2,03	-1,23	-1,90	-0,98	-0,74	-1,06	2,89	2,05	2,61
TQ51	1	3948	48,96	0,55	0,75	0,63	0,26	0,37	0,32	2,14	2,14	2,05
TQ51	2	3948	51,04	-0,53	-0,72	-0,61	-0,26	-0,37	-0,32	2,06	2,06	1,97
TQ52	1	1922	47,56	1,21	-0,86	0,31	0,38	-0,26	0,10	3,43	3,34	3,02
TQ52	2	1922	52,44	-1,10	0,78	-0,28	-0,38	0,26	-0,10	3,10	3,03	2,74
TQ66	1	1922	18,95	4,75	2,51	4,24	1,13	0,52	0,98	6,33	4,72	6,04
TQ66	2	1922	35,69	3,32	2,97	1,89	0,75	0,77	0,57	5,52	4,87	3,81
TQ66	3	1922	45,36	-4,60	-3,39	-3,26	-1,22	-0,97	-0,99	5,94	4,86	4,63
TQ90	1	1922	65,04	0,86	-1,32	-0,87	0,39	-0,64	-0,38	2,36	2,44	2,42
TQ90	2	1922	4,02	-3,02	1,34	3,50	-0,19	0,07	0,19	15,95	17,11	18,48
TQ90	3	1922	6,96	0,28	6,00	2,30	0,03	0,63	0,21	8,78	11,22	10,89
TQ90	4	1922	24,00	-1,92	1,62	1,10	-0,30	0,27	0,18	6,51	6,22	6,09
TQ101	1	3948	85,24	-0,06	-0,05	-0,23	-0,06	-0,05	-0,26	0,91	0,90	0,92
TQ101	2	3948	14,76	0,35	0,29	1,37	0,06	0,05	0,26	5,30	5,20	5,31
TQ102	1	549	66,41	0,46	1,06	0,52	0,10	0,24	0,12	4,61	4,41	4,16
TQ102	2	549	33,59	-0,91	-2,10	-1,04	-0,10	-0,24	-0,12	9,11	8,72	8,23
TQ118	1	3948	93,04	-0,02	0,08	-0,22	-0,03	0,12	-0,32	0,69	0,74	0,72
TQ118	2	3948	1,00	-1,77	-4,28	5,51	-0,06	-0,17	0,20	25,63	25,27	28,07
TQ118	3	3948	5,96	0,71	-0,67	2,61	0,09	-0,07	0,33	7,89	8,80	8,26
TQ129	1	3948	9,85	-0,35	-0,78	0,01	-0,06	-0,13	0,00	5,73	5,72	5,83
TQ129	2	3948	43,62	-0,02	0,04	0,24	0,00	0,01	0,11	2,19	2,25	2,19
TQ129	3	3948	3,54	0,42	0,00	0,00	0,05	0,00	0,00	7,27	7,19	8,22
TQ129	4	3948	42,99	0,06	0,13	-0,25	0,03	0,06	-0,11	2,10	2,13	2,13
TQ131A	1	1712	73,95	-0,10	-0,22	-0,33	-0,07	-0,14	-0,22	1,51	1,59	1,56
TQ131C	1	1712	7,72	0,40	1,17	1,68	0,03	0,10	0,13	11,08	11,06	12,27
TQ131D	1	1712	4,71	0,40	-0,13	0,25	0,01	0,00	0,00	24,51	25,21	25,09
TQ131F	1	1712	26,23	0,02	-0,13	0,93	0,00	-0,02	0,18	5,03	4,82	5,26
TQ136BOX	1	1860	18,56	0,00	0,40	0,59	0,00	0,08	0,11	5,12	4,83	5,30
TQ136A	1	1518	72,70	-0,17	-0,09	-0,20	-0,07	-0,03	-0,08	2,37	2,42	2,36
TQ136C	1	1518	9,69	0,57	1,15	0,68	0,05	0,11	0,06	10,27	10,49	10,97
TQ136D	1	1518	4,30	0,57	-0,03	0,36	0,05	0,00	0,03	11,42	12,62	10,56
TQ136F	1	1518	21,54	-0,25	0,34	1,03	-0,04	0,06	0,18	5,57	5,31	5,56

Comparison of hot deck and weighting class estimates with no imputation estimates of proportions for blacks of average ability

ITEM	RESPONSE	SAMPLE SIZE	Y-TRUE	NI RBX	HD RBX	WC RBX	NI BR	HD BR	WC BR	NI RVMSEX	HD RVMSEX	WC RVMSEX
TQ1A	1	357	66,74	-2,91	-2,91	-2,91	-0,53	-0,53	-0,53	6,16	6,16	6,16
TQ1C	1	357	25,28	-4,96	-4,96	-4,96	-0,38	-0,38	-0,38	13,89	13,89	13,89
TQ1D	1	357	4,54	-7,65	-7,65	-7,65	-0,31	-0,31	-0,31	25,33	25,33	25,33
TQ1G	1	357	15,60	-27,42	-27,42	-27,42	-2,21	-2,21	-2,21	30,08	30,08	30,08
TQ9A	1	357	64,72	-11,53	-11,53	-11,53	-2,21	-2,21	-2,21	12,65	12,65	12,65
TQ9C	1	357	42,83	-3,68	-3,68	-3,68	-0,56	-0,56	-0,56	7,47	7,47	7,47
TQ9D	1	357	7,38	-3,09	-3,09	-3,09	-0,20	-0,20	-0,20	15,69	15,69	15,69
TQ9G	1	357	11,23	-46,81	-46,81	-46,81	-4,20	-4,20	-4,20	48,12	48,12	48,12
TQ10	1	357	56,17	2,45	1,30	2,42	0,41	0,20	0,39	6,37	6,45	6,56
TQ10	2	357	13,08	1,13	2,09	3,76	0,05	0,09	0,17	19,61	21,69	22,06
TQ10	3	357	2,73	1,13	0,00	0,00	0,02	0,00	0,00	54,56	54,01	54,01
TQ10	4	357	28,03	-5,55	-3,59	-6,60	-0,61	-0,38	-0,75	10,59	10,00	10,97
TQ12	1	101	37,05	-1,57	1,26	-4,17	-0,07	0,06	-0,21	20,30	20,37	20,03
TQ12	2	101	7,38	6,82	3,73	7,07	0,12	0,06	0,12	56,71	55,66	55,40
TQ12	3	101	55,57	0,14	-1,33	1,84	0,01	-0,09	0,13	13,48	13,77	13,69
TQ29	1	255	92,75	0,68	1,28	-0,93	0,37	0,66	-0,38	1,94	2,30	2,61
TQ29	2	255	7,25	-8,72	-16,38	11,97	-0,37	-0,66	0,38	24,94	29,53	33,51
TQ33	1	107	32,20	0,74	-0,85	4,07	0,04	-0,04	0,20	18,59	19,86	20,50
TQ33	2	107	4,28	1,61	0,00	0,00	0,02	0,00	0,00	72,23	71,10	71,10
TQ33	3	107	63,52	-0,48	0,43	-2,06	-0,05	0,04	-0,23	8,28	8,94	8,90
TQ51	1	357	30,74	3,85	3,13	3,79	0,33	0,28	0,31	12,23	11,58	12,62
TQ51	2	357	69,26	-1,71	-1,39	-1,68	-0,33	-0,28	-0,31	5,43	5,14	5,60
TQ52	1	233	49,04	2,52	6,78	5,50	0,36	1,04	0,63	6,98	9,37	10,22
TQ52	2	233	50,96	-2,43	-6,53	-5,29	-0,38	-1,04	-0,63	6,71	9,02	9,84
TQ66	1	233	20,18	4,74	-16,87	-7,48	0,25	-0,94	-0,38	19,25	24,54	20,74
TQ66	2	233	32,48	-0,51	9,54	12,55	-0,03	0,60	0,77	15,06	18,38	20,44
TQ66	3	233	47,36	-1,66	0,63	-5,42	-0,26	0,09	-0,80	6,49	6,81	8,64
TQ90	1	233	37,64	1,36	9,46	-1,92	0,16	1,00	-0,18	8,53	13,37	10,59
TQ90	2	233	7,49	14,85	5,10	17,18	0,92	0,23	0,55	21,84	22,76	35,35
TQ90	3	233	10,63	-1,99	-9,67	-3,83	-0,10	-0,49	-0,17	19,34	21,84	22,04
TQ90	4	233	44,25	-3,20	-6,58	-0,34	-0,45	-0,70	-0,04	7,75	11,40	8,13
TQ101	1	357	80,90	-0,28	0,00	-1,46	-0,06	0,00	-0,30	4,46	4,48	4,94
TQ101	2	357	19,10	1,19	0,00	6,19	0,06	0,00	0,30	18,93	18,99	20,92
TQ102	1	61	61,07	0,00	0,00	3,71	0,00	0,00	0,24	15,19	15,19	15,66
TQ102	2	61	38,93	0,00	0,00	-5,83	0,00	0,00	-0,24	23,83	23,83	24,56
TQ118	1	357	87,57	0,35	0,76	0,76	0,16	0,27	0,30	2,20	2,90	2,58
TQ118	2	357	0,23	3,05	0,00	0,00	0,03	0,00	0,00	87,01	84,49	201,52
TQ118	3	357	12,21	-2,57	-5,46	-5,46	-0,17	-0,28	-0,34	14,80	20,05	16,61
TQ129	1	357	8,69	0,79	0,00	0,00	0,03	0,00	0,00	20,36	20,11	20,18
TQ129	2	357	59,08	-0,54	0,00	-1,33	-0,11	0,00	-0,26	4,78	4,61	5,28
TQ129	3	357	5,21	0,79	0,00	9,45	0,03	0,00	0,33	25,21	25,23	29,55
TQ129	4	357	27,02	0,79	0,00	1,08	0,09	0,00	0,13	8,42	8,56	7,89
TQ131A	1	103	71,73	0,00	0,00	0,42	0,00	0,00	0,04	8,44	8,27	9,00
TQ131C	1	103	7,64	0,00	0,00	13,02	0,00	0,00	0,28	45,22	44,51	48,11
TQ131D	1	103	0,30	0,00	0,00	-1,07	0,00	0,00	-0,01	99,00	97,76	98,83
TQ131F	1	103	22,48	0,00	0,00	-1,07	0,00	0,00	-0,04	19,97	18,65	22,21
TQ136BOX	1	124	18,65	0,00	0,00	10,40	0,00	0,00	0,45	21,02	21,05	25,20
TQ136A	1	101	67,13	0,00	0,00	0,00	0,00	0,00	0,00	4,80	5,70	4,90
TQ136C	1	101	11,10	0,00	0,00	0,00	0,00	0,00	0,00	25,32	24,99	20,11
TQ136D	1	101	7,23	0,00	0,00	0,00	0,00	0,00	0,00	52,85	52,34	52,03
TQ136E	1	101	15,80	0,00	0,00	0,00	0,00	0,00	0,00	22,97	22,63	21,98

Comparison of hot deck and weighting class estimates with no imputation estimates of means for the total population

ITEM	SAMPLE SIZE	Ȳ-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TQ15	11445	38.75	0.04	0.03	-0.13	0.12	0.10	-0.35	0.33	0.37	0.39
TQ16	11445	160.26	0.14	0.13	-0.01	0.22	0.21	-0.01	0.63	0.62	0.65
TQ89HA	7579	2102.30	1.20	0.88	1.37	0.87	0.56	0.96	1.81	1.79	1.98
TQ89HB	7579	2173.09	2.38	2.59	3.04	1.50	1.03	1.89	2.86	3.60	3.44
TQ141FA	15089	7039.68	-0.44	0.66	-0.15	-0.44	0.55	-0.15	1.08	1.37	1.00
TQ141FB	15089	8704.41	-0.57	-0.29	-0.43	-0.66	-0.29	-0.50	1.04	1.02	0.95

Comparison of hot deck and weighting class estimates with no imputation estimates of means for males

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TQ15	6062	41.04	0.04	0.13	-0.01	0.08	0.25	-0.03	0.46	0.53	0.47
TQ16	6062	183.64	0.22	0.12	0.17	0.25	0.13	0.18	0.92	0.94	0.99
TQ89HA	3970	2182.70	2.10	1.13	2.23	1.07	0.47	1.06	2.86	2.62	3.06
TQ89HB	3970	2304.58	3.60	3.29	4.31	1.54	0.80	1.80	4.29	5.23	4.93
TQ141FA	7357	6623.30	0.02	0.70	0.09	0.01	0.48	0.06	1.39	1.60	1.44
TQ141FB	7357	8214.18	0.09	0.26	0.07	0.07	0.19	0.06	1.27	1.40	1.26

Comparison of hot deck and weighting class estimates with no imputation estimates of means for individuals of high ability

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI $R\sqrt{MSE}$%	HD $R\sqrt{MSE}$%	WC $R\sqrt{MSE}$%
YQ15	2107	36,26	-0,08	-0,12	-0,29	-0,09	-0,13	-0,32	0,85	0,88	0,96
TQ16	2107	148,26	0,03	-0,08	-0,11	0,02	-0,06	-0,10	1,24	1,34	1,17
TQ89HA	2155	2597,94	0,91	0,58	0,79	0,47	0,29	0,42	2,12	2,04	2,02
TQ89HB	2155	2698,50	2,07	1,26	1,56	1,00	0,53	0,73	2,93	2,66	2,64
TQ141FA	2839	5327,10	-0,14	1,07	0,37	-0,06	0,49	0,18	2,08	2,42	2,04
TQ141FB	2839	7349,55	-0,41	0,53	-0,08	-0,26	0,33	-0,06	1,60	1,69	1,47

Comparison of hot deck and weighting class estimates with no imputation estimates of means for individuals o. low socio-economic status

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI $R\sqrt{MSE}$%	HD $R\sqrt{MSE}$%	WC $R\sqrt{MSE}$%
T015	3151	39.46	0.02	0.28	-0.05	0.06	0.53	-0.18	0.30	0.61	0.28
T016	3151	156.54	0.25	0.61	0.13	0.18	0.40	0.09	1.41	1.63	1.31
T089HA	1420	1638.01	3.89	3.66	3.45	1.19	0.98	1.10	5.08	5.22	4.66
T089HH	1420	1732.64	2.44	2.92	3.52	0.64	0.73	0.91	4.49	4.95	5.22
T0141FA	4220	7662.68	-0.70	1.18	-0.64	-0.43	0.54	-0.40	1.77	2.48	1.72
T0141FB	4220	8966.36	-1.18	-0.67	-1.19	-0.75	-0.35	-0.76	1.95	2.03	1.95

Comparison of hot deck and weighting class estimates with no imputation estimates of means for blacks

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI $R\sqrt{MSE}$%	HD $R\sqrt{MSE}$%	WC $R\sqrt{MSE}$%
TQ15	1458	37.68	0.49	-0.14	-0.02	0.65	-0.13	-0.03	0.90	1.07	0.85
TQ16	1458	145.73	0.54	0.79	-0.06	0.21	0.30	-0.02	2.66	2.68	2.28
TQ89HA	928	1702.03	4.29	5.20	6.02	0.90	0.90	1.18	6.42	7.78	7.87
TQ89HB	928	1774.33	1.94	4.03	4.98	0.31	0.60	0.79	6.52	7.81	8.02
TQ141FA	1963	5945.88	-3.02	-0.62	-0.90	-1.03	-0.20	-0.34	4.21	3.15	2.78
TQ141FB	1963	6989.57	-1.80	1.07	0.28	-0.61	0.27	0.11	3.43	4.06	2.59

Comparison of hot deck and weighting class estimates with no imputation estimates of means for the South

ITEM	SAMPLE SIZE	Ȳ-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVRSE%	HD RVRSE%	WC RVRSE%
TQ15	3040	39.06	-0.02	-0.10	-0.10	-0.04	-0.15	-0.14	0.59	0.68	0.71
TQ16	3040	162.99	0.09	0.28	0.23	0.08	0.30	0.21	1.10	0.96	1.11
TQ89IIA	1922	2127.80	-0.45	-0.21	-0.15	-0.24	-0.10	-0.08	1.90	1.97	1.78
TQ89IIB	1922	2196.52	0.65	1.90	1.77	0.24	0.79	0.75	2.75	5.07	2.94
TQ141FA	3948	7352.66	-0.79	0.80	-0.62	-0.70	0.50	-0.54	1.38	1.80	1.50
TQ141FH	3948	9119.58	-0.30	-0.60	-0.37	-0.24	-0.42	-0.31	1.27	1.55	1.23

Comparison of hot deck and weighting class estimates with no imputation estimates of means for blacks of average ability

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
T015	256	37.11	0.60	0.30	0.79	0.33	0.13	0.37	2.08	2.23	2.25
T016	256	162.89	0.94	-0.16	0.49	0.11	-0.02	0.06	7.95	7.66	7.96
T089HA	233	1890.48	-2.05	1.66	3.82	-0.32	0.26	0.69	6.51	6.52	6.73
T089HB	233	1974.43	-0.37	1.03	4.47	-0.03	0.12	0.71	7.26	8.37	7.67
T141FA	357	5648.06	3.06	1.77	3.61	0.45	0.24	0.53	7.90	7.60	7.67
T141FB	357	6901.88	-0.03	0.60	-0.01	-0.06	0.08	0.00	7.01	7.27	6.55

Appendix I

COMPARISON OF HOT DECK AND WEIGHTING CLASS ESTIMATES FOR ALL DOMAINS FOR SELECTED ITEMS

Glossary of Terms Used in the Tables

SAMPLE SIZE - number of sample members eligible to respond to a particular item for the domain under consideration.

$\bar{Y}$-TRUE - the estimate obtained using the telephone corrected and completed data.

NI - no imputation--refers to the estimates obtained using no imputation or editing procedure on the experimental data set.

HD - hot deck--refers to the estimates obtained after the experimental data set had missing data and violations of routing patterns corrected, using a hot deck procedure.

WC - weighting class--refers to the estimates obtained after the experimental data set had missing data and violations of routing patterns corrected using a weighting class procedure.

RB% - the relative bias--defined to be the ratio of the bias to $\bar{Y}$-TRUE, expressed as a percentage.

BR - the bias ratio, defined to be the bias divided by the standard deviation of the estimate.

$R\sqrt{MSE}\%$ - the relative root mean square error--defined to be the square root of the mean square error divided by the value of $\bar{Y}$-TRUE, expressed as a percentage.

Legend for Definition of Domain Level Within Domains

Domain	Domain Level	Definition
Total	1	Total
Sex	1	Males
	2	Females
Aptitude	1	Low
	2	Middle
	3	High
SES	1	Low
	2	Middle
	3	High
Race	1	Black
	2	White
	3	Hispanic
	4	Other
Region	1	Northeast
	2	South
	3	North Central
	4	West
Race by Ability	1	Blacks of Low Ability
	2	Blacks of Middle Ability
	4	Whites of Low Ability
	5	Whites of Middle Ability
	6	Whites of High Ability
	10	Others of Low Ability
	11	Others of Middle Ability
	12	Others of High Ability

The tabulations for blacks of high ability and all classifications of Hispanics by ability were excluded because their small sample sizes did not allow the computation of valid balanced repeated replication variance estimates.

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ1A, response 1

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVARSE%	HD RVARSE%	WC RVARSE%
TOTAL	1	15089	72.29	-2.38	-2.40	-2.52	-4.21	-4.33	-4.26	2.45	2.47	2.59
SEX	1	7357	77.00	-3.28	-3.30	-3.40	-5.38	-5.52	-5.27	3.33	3.35	3.47
SEX	2	7637	67.66	-1.37	-1.36	-1.49	-1.84	-1.83	-1.99	1.56	1.55	1.67
APTITUDE	1	2945	72.10	-1.16	-1.22	-1.38	-1.10	-1.14	-1.30	1.57	1.62	1.74
APTITUDE	2	4788	73.80	-2.05	-2.04	-2.09	-2.36	-2.36	-2.38	2.23	2.21	2.27
APTITUDE	3	2039	71.74	-4.23	-4.17	-4.36	-3.01	-3.00	-3.04	4.46	4.39	4.59
SES	1	4220	69.91	-1.47	-1.51	-1.54	-1.24	-1.26	-1.34	1.89	1.93	1.93
SES	2	7207	74.08	-2.18	-2.21	-2.28	-2.18	-2.23	-2.23	2.40	2.42	2.50
SES	3	3431	71.37	-3.74	-3.68	-3.95	-3.51	-3.52	-3.55	3.89	3.82	4.11
RACE	1	1963	69.37	-1.98	-1.97	-2.17	-1.00	-0.98	-1.11	2.81	2.82	2.91
RACE	2	11679	72.83	-2.44	-2.46	-2.56	-3.28	-3.36	-3.27	2.55	2.56	2.68
RACE	3	91	72.10	-0.19	0.00	-0.70	-0.01	0.00	-0.07	9.87	9.92	9.97
RACE	4	1251	70.76	-2.43	-2.40	-2.51	-0.98	-0.97	-1.01	3.47	3.44	3.53
REGION	1	3051	71.18	-2.31	-2.29	-2.44	-2.35	-2.33	-2.51	2.51	2.50	2.63
REGION	2	3948	73.45	-2.87	-2.95	-3.00	-3.13	-3.23	-3.13	3.01	3.09	3.15
REGION	3	5551	74.00	-2.05	-2.09	-2.20	-2.00	-2.02	-2.13	2.29	2.34	2.42
REGION	4	2539	68.99	-2.20	-2.14	-2.34	-1.75	-1.71	-1.82	2.54	2.48	2.67
RACE BY ABILITY	1	822	70.14	-1.47	-1.33	-1.77	-0.58	-0.52	-0.74	2.90	2.87	2.98
RACE BY ABILITY	2	357	66.74	-2.91	-2.91	-2.91	-0.53	-0.53	-0.53	6.16	6.16	6.16
RACE BY ABILITY	4	1632	74.40	-1.44	-1.61	-1.61	-1.02	-1.14	-1.09	2.02	2.14	2.19
RACE BY ABILITY	5	4076	74.26	-1.95	-1.93	-1.99	-1.91	-1.91	-1.94	2.20	2.16	2.24
RACE BY ABILITY	6	2656	71.82	-4.28	-4.22	-4.43	-3.25	-3.25	-3.25	4.48	4.42	4.63
RACE BY ABILITY	10	452	66.75	0.60	0.72	0.37	0.16	0.19	0.10	3.78	3.78	3.78
RACE BY ABILITY	11	328	73.38	-2.94	-2.94	-2.94	-0.73	-0.73	-0.73	4.96	4.96	4.96
RACE BY ABILITY	12	131	69.00	-2.64	-2.64	-2.64	-0.49	-0.49	-0.49	5.92	5.92	5.92

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ10, response 1

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TOTAL	1	15089	61.22	0.09	0.02	-0.12	0.10	0.03	-0.14	0.87	0.87	0.91
SEX	1	7357	68.57	0.00	-0.01	-0.12	0.00	-0.01	-0.17	0.72	0.74	0.76
SEX	2	7637	53.85	0.15	0.05	-0.15	0.10	0.04	-0.10	1.42	1.36	1.47
APTITUDE	1	2945	65.97	0.25	-0.28	-0.18	0.16	-0.19	-0.12	1.60	1.50	1.55
APTITUDE	2	4788	63.10	0.03	0.14	0.04	0.02	0.10	0.02	1.43	1.46	1.43
APTITUDE	3	2839	53.65	-0.30	-0.52	-0.55	-0.13	-0.24	-0.23	2.21	2.23	2.37
SES	1	4220	62.88	-0.13	-0.38	-0.38	-0.09	-0.26	-0.29	1.33	1.50	1.36
SES	2	7207	64.75	0.23	0.22	0.06	0.26	0.24	0.07	0.93	0.97	0.93
SES	3	3431	52.66	-0.03	-0.09	-0.31	-0.02	-0.04	-0.16	1.89	1.84	1.92
RACE	1	1963	59.55	0.89	0.29	0.48	0.43	0.13	0.21	2.26	2.29	2.24
RACE	2	11679	61.37	0.07	0.09	-0.11	0.07	0.09	-0.10	1.00	1.01	1.04
RACE	3	91	64.42	0.00	0.00	0.00	0.00	0.00	0.00	12.08	12.08	12.08
RACE	4	1231	61.18	-0.59	-1.11	-1.11	-0.29	-0.51	-0.49	2.12	2.43	2.48
REGION	1	3051	59.69	-0.39	-0.41	-0.71	-0.36	-0.37	-0.60	1.12	1.17	1.36
REGION	2	3948	61.38	0.26	0.29	0.20	0.29	0.32	0.20	0.94	0.95	0.99
REGION	3	5551	65.58	0.21	-0.15	-0.23	0.15	-0.11	-0.16	1.39	1.37	1.41
REGION	4	2539	55.71	0.29	0.61	0.40	0.10	0.22	0.14	2.74	2.85	2.74
RACE BY ABILITY	1	822	60.72	0.94	-0.33	0.88	0.30	-0.12	0.26	3.21	2.79	3.46
RACE BY ABILITY	2	357	56.17	2.45	1.30	2.42	0.41	0.20	0.39	6.37	6.45	6.56
RACE BY ABILITY	4	1632	68.93	0.11	-0.11	-0.31	0.06	-0.06	-0.18	1.72	1.71	1.72
RACE BY ABILITY	5	4076	63.53	-0.09	0.09	-0.09	-0.06	0.06	-0.06	1.44	1.47	1.43
RACE BY ABILITY	6	2656	53.94	-0.24	-0.34	-0.41	-0.11	-0.17	-0.19	2.08	2.07	2.18
RACE BY ABILITY	10	452	62.00	-0.46	-1.02	-1.23	-0.10	-0.22	-0.29	4.30	4.65	4.37
RACE BY ABILITY	11	328	62.31	0.00	0.00	0.00	0.00	0.00	0.00	3.73	3.73	3.73
RACE BY ABILITY	12	131	65.51	-2.54	-5.31	-4.37	-0.32	-0.57	-0.45	8.18	10.61	10.51

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ12, response 1

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVRSE%	HD RVRSE%	WC RVRSE%
TOTAL	1	3644	25.66	5.03	3.27	2.18	1.41	0.84	0.65	6.16	5.07	4.00
SEX	1	1295	36.19	1.93	0.58	-0.41	0.44	0.12	-0.09	4.77	4.54	4.20
SEX	2	2322	19.19	8.64	6.30	5.12	1.44	1.05	0.88	10.52	8.69	7.72
APTITUDE	1	701	32.75	1.84	-0.11	-2.74	0.28	-0.01	-0.49	6.79	6.26	6.16
APTITUDE	2	1042	22.23	4.83	4.05	2.85	0.73	0.60	0.45	8.16	7.78	6.86
APTITUDE	3	732	22.03	4.96	0.60	1.91	0.64	0.07	0.25	9.14	8.26	7.68
SES	1	1069	30.32	4.32	1.46	1.85	1.22	0.43	0.56	5.53	3.70	3.77
SES	2	1603	26.08	5.22	5.10	2.47	0.85	0.73	0.41	8.01	8.62	6.45
SES	3	904	19.95	7.23	3.63	3.28	0.79	0.34	0.42	11.64	9.33	8.37
RACE	1	505	38.87	4.59	2.50	-0.29	0.64	0.32	-0.03	8.47	8.05	7.40
RACE	2	2757	23.47	4.97	3.40	3.26	1.01	0.66	0.64	6.98	6.12	6.02
RACE	3	24	46.07	-9.73	7.46	-12.13	-0.38	0.24	-0.48	27.13	30.90	27.92
RACE	4	323	20.80	9.42	3.38	1.42	1.27	0.40	0.17	11.97	8.92	8.12
REGION	1	780	30.26	2.27	0.51	0.19	0.22	0.04	0.01	10.50	11.08	10.31
REGION	2	908	22.91	8.44	6.16	5.37	1.24	0.87	0.68	10.83	9.38	9.52
REGION	3	1264	23.14	6.29	4.16	1.62	0.93	0.62	0.28	9.22	7.83	5.98
REGION	4	692	26.52	3.93	2.98	1.97	0.73	0.45	0.33	6.64	7.26	6.13
RACE BY ABILITY	1	209	38.45	2.34	0.66	-2.02	0.23	0.06	-0.23	10.08	10.90	8.71
RACE BY ABILITY	2	101	37.05	-1.57	1.26	-4.17	-0.07	0.06	-0.21	20.30	20.31	20.03
RACE BY ABILITY	4	357	29.56	1.67	-0.89	-0.13	0.16	-0.09	-0.01	10.46	9.31	9.68
RACE BY ABILITY	5	887	20.79	6.88	5.49	4.46	0.86	0.71	0.60	10.54	9.40	8.60
RACE BY ABILITY	6	685	22.17	4.99	1.27	2.64	0.56	0.13	0.30	10.15	9.59	9.14
RACE BY ABILITY	10	125	34.08	3.80	-1.30	-9.37	0.42	-0.10	-1.20	9.80	13.05	12.19
RACE BY ABILITY	11	87	25.42	-3.21	-4.26	0.00	-0.19	-0.25	0.00	16.73	16.82	16.61
RACE BY ABILITY	12	36	19.85	5.64	-15.75	-15.75	0.12	-0.42	-0.42	44.24	40.01	40.01

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ51, response 2

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TOTAL	1	15089	52.87	-0.43	-0.62	-0.64	-0.36	-0.52	-0.56	1.25	1.34	1.32
SEX	1	7357	56.24	-0.41	-0.58	-0.69	-0.27	-0.37	-0.48	1.54	1.65	1.59
SEX	2	7637	49.54	-0.48	-0.6.	-0.62	-0.38	-0.50	-0.50	1.34	1.49	1.38
APTITUDE	1	2945	31.57	-0.12	0.42	0.18	-0.04	0.17	0.07	2.57	2.50	2.58
APTITUDE	2	4788	52.01	-0.88	-0.99	-1.02	-0.48	-0.54	-0.57	2.01	2.07	2.06
APTITUDE	3	2839	70.10	-0.41	-0.36	-0.47	-0.36	-0.33	-0.41	1.21	1.17	1.23
SES	1	4220	35.17	-0.09	-0.52	0.25	-0.03	-0.17	0.10	2.90	3.13	2.55
SES	2	7207	48.94	-0.65	-0.73	-0.88	-0.44	-0.47	-0.62	1.62	1.70	1.67
SES	3	3431	70.49	-0.61	-0.51	-0.74	-0.62	-0.51	-0.75	1.15	1.13	1.23
RACE	1	1963	49.79	0.11	-0.27	-0.56	0.03	-0.07	-0.17	3.29	3.45	3.29
RACE	2	11679	53.96	-0.51	-0.61	-0.69	-0.38	-0.45	-0.52	1.43	1.48	1.49
RACE	3	91	47.41	-3.12	-3.12	-3.12	-0.27	-0.27	-0.27	11.75	11.75	11.75
RACE	4	1231	45.62	-0.31	-0.97	-0.18	-0.08	-0.25	-0.05	3.75	3.90	3.66
REGION	1	3051	53.83	-0.70	-0.74	-0.79	-0.23	-0.24	-0.26	3.11	3.16	3.16
REGION	2	3940	51.04	-0.53	-0.72	-0.61	-0.26	-0.37	-0.32	2.06	2.06	1.97
REGION	3	5551	50.44	0.09	-0.12	-0.34	0.05	-0.06	-0.18	1.78	1.86	1.85
REGION	4	2539	58.77	-0.75	-1.03	-0.93	-0.36	-0.50	-0.47	2.11	2.27	2.17
RACE BY ABILITY	1	822	42.00	-0.01	0.93	0.07	0.00	0.19	0.01	4.70	4.90	5.21
RACE BY ABILITY	2	357	69.26	-1.71	-1.39	-1.68	-0.33	-0.28	-0.31	5.43	5.14	5.60
RACE BY ABILITY	4	1632	27.98	0.00	0.06	0.21	0.00	0.01	0.04	4.44	4.29	4.27
RACE BY ABILITY	5	4076	51.11	-0.76	-0.93	-0.94	-0.37	-0.46	-0.47	2.17	2.20	2.22
RACE BY ABILITY	6	2656	77.60	-0.38	-0.27	-0.39	-0.33	-0.24	-0.35	1.19	1.17	1.18
RACE BY ABILITY	10	452	30.72	0.69	0.83	0.33	0.08	0.10	0.03	8.05	7.98	8.77
RACE BY ABILITY	11	328	49.16	-1.45	-1.45	-1.45	-0.17	-0.17	-0.17	8.23	8.23	8.23
RACE BY ABILITY	12	131	87.80	-1.17	-2.29	-2.29	-0.37	-0.80	-0.69	3.32	3.65	4.01

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ66, response 2

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	Y-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TOTAL	1	7579	32.03	4.15	5.16	5.02	2.32	3.25	2.99	4.52	5.39	5.29
SEX	1	3970	35.38	3.95	4.31	4.39	1.61	1.85	1.86	4.65	4.90	4.98
SEX	2	3572	28.27	4.47	6.41	6.04	1.20	1.01	1.66	5.81	7.32	7.04
APTITUDE	1	890	30.22	7.09	14.07	13.00	1.38	1.92	1.86	8.74	15.84	14.74
APTITUDE	2	2344	32.84	3.77	5.66	4.69	1.24	1.89	1.65	4.84	6.40	5.48
APTITUDE	3	2155	32.40	3.77	3.45	3.23	1.04	0.96	0.84	5.21	4.96	5.03
SES	1	1420	29.91	3.43	9.82	9.16	0.71	1.80	1.86	5.89	11.23	10.40
SES	2	3423	29.60	5.46	8.21	7.72	2.21	2.38	2.71	5.99	8.91	8.22
SES	3	2651	35.07	3.20	0.57	1.06	1.14	0.16	0.44	4.25	3.58	2.60
RACE	1	928	35.77	2.31	8.72	5.73	0.42	1.51	1.22	5.94	10.46	7.41
RACE	2	5994	31.50	4.20	4.49	4.83	1.86	2.38	2.42	4.77	4.87	5.22
RACE	3	39	25.28	20.13	55.23	70.70	0.50	1.12	1.46	44.57	73.94	85.64
RACE	4	564	34.50	5.65	5.06	2.19	1.07	0.90	0.29	7.71	7.55	7.72
REGION	1	1604	25.56	6.30	9.53	10.89	1.96	2.62	2.63	7.06	10.20	11.65
REGION	2	1922	35.69	3.32	2.97	1.89	0.75	0.77	0.57	5.52	4.87	3.31
REGION	3	2619	32.57	3.46	5.40	5.05	1.28	1.92	1.68	4.39	6.18	5.87
REGION	4	1434	34.72	4.16	3.53	3.71	1.21	0.97	0.93	5.39	5.06	5.43
RACE BY ABILITY	1	351	36.57	3.93	16.16	10.19	0.49	1.23	1.47	8.83	20.76	12.32
RACE BY ABILITY	2	233	32.48	-0.51	9.54	12.55	-0.03	0.60	0.77	15.06	18.38	20.44
RACE BY ABILITY	4	407	26.80	9.01	8.75	11.84	0.85	0.80	1.07	13.86	13.91	16.17
RACE BY ABILITY	5	1927	32.38	3.89	5.90	4.69	1.03	1.61	1.38	5.40	6.94	5.78
RACE BY ABILITY	6	2001	32.51	3.91	3.54	3.51	0.96	0.90	0.81	5.49	5.28	5.58
RACE BY ABILITY	10	142	30.60	9.64	21.55	18.76	1.02	2.10	1.48	13.50	23.87	22.62
RACE BY ABILITY	11	171	40.81	6.78	-2.58	-7.54	0.54	-0.20	-0.52	14.09	12.88	16.18
RACE BY ABILITY	12	110	28.24	1.01	-0.72	-0.72	0.06	-0.04	-0.04	16.41	15.64	16.61

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ118, response 3

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TOTAL	1	15089	6.42	1.16	0.17	2.10	0.29	0.04	0.46	4.06	3.90	4.95
SEX	1	7357	11.44	0.35	0.15	0.68	0.09	0.03	0.16	3.97	4.04	4.22
SEX	2	7637	1.24	1.12	-0.08	15.63	0.09	0.00	0.84	11.86	11.77	24.21
APTITUDE	1	2945	7.05	2.09	-0.49	6.11	0.26	-0.06	0.79	8.32	7.46	9.82
APTITUDE	2	4788	6.27	0.49	-0.22	-0.04	0.09	-0.04	0.00	5.17	5.61	6.03
APTITUDE	3	2839	5.17	1.53	1.67	0.81	0.20	0.22	0.08	7.58	7.60	9.20
SES	1	4220	8.33	0.94	0.30	1.22	0.13	0.04	0.15	7.28	7.37	7.97
SES	2	7207	6.46	1.50	-0.10	2.11	0.34	-0.02	0.42	4.81	4.58	5.39
SES	3	3431	4.03	1.58	0.64	4.62	0.14	0.05	0.45	11.25	10.95	11.23
RACE	1	1963	9.72	3.07	-1.31	2.53	0.32	-0.13	0.24	9.83	9.90	10.52
RACE	2	11679	5.90	1.07	0.52	2.23	0.25	0.12	0.47	4.42	4.28	5.20
RACE	3	91	8.61	1.53	12.96	4.56	0.02	0.22	0.07	58.30	59.45	57.50
RACE	4	1231	6.23	0.03	-2.68	0.23	0.00	-0.20	0.01	11.74	13.23	12.49
REGION	1	3051	5.36	1.35	0.32	3.17	0.07	0.01	0.18	17.18	16.84	17.30
REGION	2	3948	5.96	0.71	-0.67	2.61	0.09	-0.07	0.33	7.89	8.80	8.26
REGION	3	5551	7.17	0.97	0.28	1.21	0.25	0.06	0.22	3.92	4.21	5.52
REGION	4	2539	7.53	1.81	1.00	1.68	0.55	0.28	0.45	3.75	3.69	4.09
RACE BY ABILITY	1	822	7.58	5.07	1.64	11.93	0.44	0.14	0.87	12.52	11.30	18.12
RACE BY ABILITY	2	357	12.21	-2.57	-5.46	-5.46	-0.17	-0.28	-0.34	14.80	20.05	16.61
RACE BY ABILITY	4	1632	6.67	1.44	-0.75	5.44	0.17	-0.09	0.72	8.29	8.35	9.28
RACE BY ABILITY	5	4076	5.90	0.92	0.44	0.50	0.13	0.06	0.06	6.78	6.88	7.62
RACE BY ABILITY	6	2656	5.10	1.55	1.79	0.87	0.21	0.24	0.09	7.33	7.51	8.81
RACE BY ABILITY	10	452	7.49	0.70	-2.89	0.54	0.03	-0.14	0.03	19.10	20.31	17.50
RACE BY ABILITY	11	328	5.70	1.02	0.00	0.00	0.04	0.00	0.00	23.19	22.68	22.60
RACE BY ABILITY	12	131	4.37	0.70	0.00	0.00	0.01	0.00	0.00	53.63	53.12	53.12

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ15

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	Ȳ-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TOTAL	1	11445	38.75	0.04	0.03	-0.13	0.12	0.10	-0 35	0.33	0.37	0.39
SEX	1	6062	41.04	0.04	0.13	-0.01	0.08	0.25	-0.03	0.46	0.53	0.47
SEX	2	5315	36.05	0.03	-0.07	-0.27	0.09	-0.16	-0.60	0.39	0.49	0.53
APTITUDE	1	2244	40.77	0.08	-0.05	-0.36	0.12	-0.06	-0.53	0.65	0.75	0.76
APTITUDE	2	3706	38.98	0.02	0.05	0.00	0.04	0.11	0.01	0.43	0.49	0.47
APTITUDE	3	2107	36.26	-0.08	-0.12	-0.23	-0.09	-0.13	-0.32	0.85	0.88	0.96
SES	1	3151	39.46	0.02	0.28	-0.05	0.06	0.53	-0.18	0.30	0.61	0.28
SES	2	5604	39.42	0.06	-0.11	-0.19	0.19	-0.31	-0.54	0.33	0.37	0.40
SES	3	2527	36.64	0.01	0.09	-0.06	0.02	0.10	-0.07	0.78	0.87	0.82
RACE	1	1458	37.68	0.49	-0.14	-0.02	0.65	-0.13	-0.03	0.90	1.07	0.83
RACE	2	0922	38.85	-0.01	0.00	-0.15	-0.02	0.02	-0.31	0.43	0.48	0.50
RACE	3	67	40.04	0.09	0.04	0.00	0.01	0.00	0.00	6.94	6.75	6.77
RACE	4	908	38.63	0.12	0.71	0.00	0.12	0.52	0.00	1.00	1.53	1.25
REGION	1	2271	37.60	-0.11	0.06	-0.19	-0.17	0.08	-0.25	0.62	0.73	0.79
REGION	2	3040	39.06	-0.02	-0.10	-0.10	-0.04	-0.15	-0.14	0.59	0.68	0.71
REGION	3	4287	39.59	0.24	0.12	-0.05	0.49	0.27	-0.10	0.56	0.48	0.50
REGION	4	1847	38.43	0.03	0.10	-0.25	0.02	0.06	-0.17	1.43	1.46	1.44
RACE BY ABILITY	1	613	38.13	0.06	-1.29	-0.75	0.08	-1.28	-0.90	0.82	1.63	1.12
RACE BY ABILITY	2	256	37.11	0.66	0.30	0.79	0.33	0.13	0.37	2.08	2.23	2.25
RACE BY ABILITY	4	1275	41.63	0.00	0.01	-0.25	0.00	0.02	-0.44	0.64	0.80	0.61
RACE BY ABILITY	5	3189	39.12	0.00	0.02	-0.04	-0.01	0.04	-0.08	0.50	0.53	0.54
RACE BY ABILITY	6	1971	36.36	-0.08	-0.02	-0.20	-0.09	-0.02	-0.20	0.94	0.99	1.02
RACE BY ABILITY	10	327	40.89	0.38	1.62	-0.13	0.24	0.66	-0.07	1.62	2.95	1.79
RACE BY ABILITY	11	241	37.95	-0.08	0.36	0.23	-0.06	0.23	0.16	1.44	1.56	1.44
RACE BY ABILITY	12	95	33.83	0.00	-2.25	-2.43	0.00	-0.49	-0.52	3.86	5.10	5.21

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ16

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI $R\sqrt{MSE}$%	HD $R\sqrt{MSE}$%	WC $R\sqrt{MSE}$%
TOTAL	1	11445	160.26	0.14	0.13	-0.01	0.22	0.21	-0.01	0.63	0.62	0.65
SEX	1	6062	183.64	0.22	0.12	0.17	0.25	0.13	0.18	0.92	0.94	0.99
SEX	2	5315	132.93	-0.02	0.13	-0.29	-0.02	0.15	-0.30	0.96	0.91	0.99
APTITUDE	1	2244	168.67	0.23	-0.15	-0.28	0.21	-0.14	-0.26	1.12	1.08	1.09
APTITUDE	2	3706	164.41	0.22	0.40	0.15	0.15	0.28	0.11	1.48	1.46	1.40
APTITUDE	3	2107	148.26	0.03	-0.06	-0.11	0.02	-0.06	-0.10	1.24	1.34	1.17
SES	1	3151	156.54	0.25	0.61	0.13	0.18	0.40	0.09	1.41	1.63	1.37
SES	2	5604	166.82	0.14	-0.13	0.00	0.12	-0.13	0.00	1.10	1.00	1.02
SES	3	2527	150.71	0.02	0.31	-0.15	0.01	0.20	-0.09	1.56	1.58	1.56
RACE	1	1458	145.73	0.54	0.79	-0.06	0.21	0.30	-0.02	2.66	2.68	2.28
RACE	2	8922	162.09	0.08	0.08	-0.01	0.11	0.12	-0.02	0.70	0.69	0.72
RACE	3	67	148.04	1.14	1.14	0.92	0.13	0.13	0.10	8.81	8.45	8.61
RACE	4	908	160.58	0.16	-0.31	-0.03	0.09	-0.15	-0.01	1.76	2.11	2.08
REGION	1	2271	157.34	0.00	-0.33	-0.22	0.00	-0.25	-0.16	1.24	1.35	1.36
REGION	2	3040	162.99	0.09	0.28	0.23	0.08	0.30	0.21	1.10	0.96	1.11
REGION	3	4287	156.40	0.44	0.46	0.05	0.31	0.30	0.03	1.46	1.58	1.37
REGION	4	1847	167.04	-0.12	-0.06	-0.25	-0.05	-0.02	-0.12	2.14	2.05	2.08
RACE BY ABILITY	1	613	142.70	0.17	0.95	-0.25	0.05	0.31	-0.09	3.20	3.18	2.65
RACE BY ABILITY	2	256	162.09	0.94	-0.16	0.49	0.11	-0.02	0.06	7.95	7.66	7.96
RACE BY ABILITY	4	1275	177.89	0.14	-0.41	-0.26	0.09	-0.25	-0.16	1.60	1.65	1.59
RACE BY ABILITY	5	3189	164.46	0.19	0.49	0.15	0.12	0.32	0.10	1.63	1.61	1.51
RACE BY ABILITY	6	1971	148.57	0.05	0.08	0.00	0.04	0.06	0.00	1.28	1.36	1.21
RACE BY ABILITY	10	327	168.00	0.12	-0.49	-0.30	0.04	-0.17	-0.11	2.70	2.80	2.70
RACE BY ABILITY	11	241	164.23	0.07	-0.40	-0.06	0.01	-0.09	-0.01	4.17	4.54	4.43
RACE BY ABILITY	12	95	145.56	0.24	-3.10	-2.23	0.05	-0.56	-0.37	4.37	6.29	6.41

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ89HA

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	Ȳ-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVRSE%	HD RVRSE%	WC RVRSE%
TOTAL	1	7579	2102.30	1.20	0.88	1.37	0.87	0.56	0.96	1.81	1.79	1.98
SEX	1	3970	2102.70	2.10	1.13	2.23	1.07	0.47	1.06	2.86	2.62	3.06
SEX	2	3572	2011.99	0.08	0.58	0.34	0.04	0.25	0.16	1.98	2.33	2.06
APTITUDE	1	890	1309.39	4.58	3.74	5.03	1.02	0.58	1.10	6.40	7.41	6.78
APTITUDE	2	2344	1884.99	-0.30	0.30	1.12	-0.11	0.12	0.42	2.69	2.36	2.87
APTITUDE	3	2155	2597.94	0.91	0.58	0.79	0.47	0.29	0.42	2.12	2.04	2.02
SES	1	1420	1638.01	3.89	3.66	3.45	1.19	0.98	1.10	5.08	5.22	4.66
SES	2	3423	1885.44	0.75	0.03	1.20	0.38	0.01	0.61	2.09	2.10	2.30
SES	3	2651	2574.40	0.96	0.78	0.98	0.70	0.48	0.72	1.66	1.77	1.67
RACE	1	928	1702.03	4.29	5.20	6.02	0.90	0.90	1.18	6.42	7.78	7.87
RACE	2	5994	2170.40	0.89	0.37	0.89	0.58	0.22	0.57	1.75	1.68	1.79
RACE	3	39	1688.77	27.07	14.26	20.40	1.32	0.51	1.24	33.93	31.25	26.19
RACE	4	564	1823.83	-0.29	1.99	1.18	-0.07	0.59	0.34	3.70	3.88	3.61
REGION	1	1604	2547.43	2.39	0.75	1.54	0.67	0.22	0.47	4.26	3.44	3.61
REGION	2	1922	2127.80	-0.45	-0.21	-0.15	-0.24	-0.10	-0.08	1.90	1.97	1.78
REGION	3	2619	1870.25	2.31	3.12	3.22	1.73	1.61	2.11	2.67	3.67	3.56
REGION	4	1434	1709.27	0.08	-0.25	1.02	0.02	-0.06	0.34	3.20	3.86	3.17
RACE BY ABILITY	1	331	1432.28	16.08	15.39	14.56	1.63	1.12	1.37	18.86	20.60	18.00
RACE BY ABILITY	2	233	1890.48	-2.03	1.66	3.82	-0.32	0.26	0.69	6.51	6.52	6.73
RACE BY ABILITY	4	407	1407.99	-0.31	-2.70	0.15	-0.04	-0.32	0.02	7.37	8.67	6.61
RACE BY ABILITY	5	1927	1903.80	0.10	0.09	1.02	0.04	0.03	0.41	2.49	2.32	2.65
RACE BY ABILITY	6	2001	2588.37	0.81	0.50	0.68	0.41	0.25	0.35	2.13	2.07	2.03
RACE BY ABILITY	10	142	1269.38	-2.12	5.17	2.60	-0.19	0.44	0.25	11.28	12.63	10.34
RACE BY ABILITY	11	171	1631.96	-5.39	-1.91	-1.99	-0.70	-0.26	-0.25	9.36	7.47	7.96
RACE BY ABILITY	12	110	2562.29	3.09	2.37	2.65	0.62	0.47	0.54	5.82	5.57	5.56

238

238

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ89HB

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	Y-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TOTAL	1	7579	2173.09	2.38	2.59	3.04	1.50	1.03	1.89	2.86	3.60	3.44
SEX	1	3970	2304.58	3.60	3.29	4.31	1.54	0.80	1.80	4.29	5.23	4.93
SEX	2	3572	2025.20	0.85	1.72	1.46	0.33	0.66	0.53	2.65	3.35	3.09
APTITUDE	1	890	1547.86	2.67	5.24	4.72	0.39	0.32	0.73	7.34	17.15	7.96
APTITUDE	2	2344	1927.20	3.24	4.35	5.47	0.85	1.20	1.55	4.98	5.66	6.50
APTITUDE	3	2155	2698.50	2.07	1.26	1.56	1.00	0.53	0.73	2.93	2.66	2.64
SES	1	1420	1732.64	2.44	2.92	3.52	0.64	0.73	0.91	4.49	4.93	5.22
SES	2	3423	1917.68	1.83	2.10	3.05	0.80	0.48	1.38	2.75	4.79	3.76
SES	3	2651	2686.24	2.94	2.90	2.99	1.11	1.13	1.16	3.96	3.88	3.95
RACE	1	928	1774.33	1.94	4.03	4.98	0.31	0.60	0.79	6.52	7.81	8.02
RACE	2	5994	2235.08	2.16	2.22	2.70	1.15	0.71	1.44	2.87	3.83	3.29
RACE	3	39	2032.15	23.42	20.85	17.95	1.08	0.80	1.06	31.79	33.31	24.65
RACE	4	564	1947.20	3.69	4.81	4.62	0.70	0.94	0.85	6.39	7.00	7.12
REGION	1	1604	2607.09	2.25	1.18	2.15	0.71	0.35	0.66	3.87	3.54	3.88
REGION	2	1922	2196.52	0.65	1.90	1.77	0.24	0.79	0.75	2.75	3.07	2.94
REGION	3	2619	1915.16	5.31	6.09	6.51	1.09	1.30	1.43	7.20	7.67	7.94
REGION	4	1434	1917.30	1.60	1.33	1.85	0.72	0.16	0.86	2.73	8.14	2.82
RACE BY ABILITY	1	331	1492.17	6.60	12.75	10.39	0.41	0.82	0.67	17.22	20.06	18.57
RACE BY ABILITY	2	233	1974.43	-0.27	1.03	4.47	-0.03	0.12	0.71	7.26	8.37	7.67
RACE BY ABILITY	4	407	1635.61	1.97	1.49	1.89	0.24	0.05	0.25	8.27	27.19	7.71
RACE BY ABILITY	5	1927	1931.97	3.11	3.94	5.16	0.74	0.94	1.33	5.20	5.72	6.45
RACE BY ABILITY	6	2001	2688.20	2.05	1.30	1.58	0.89	0.49	0.65	3.09	2.95	2.89
RACE BY ABILITY	10	142	1359.33	-3.98	5.27	3.87	-0.31	0.40	0.31	13.18	14.02	12.74
RACE BY ABILITY	11	171	1802.24	10.38	11.67	11.19	0.64	0.74	0.69	19.08	19.57	19.67
RACE BY ABILITY	12	110	2686.06	3.01	0.52	0.98	0.41	0.07	0.14	7.87	7.11	6.94

Comparison of hot deck and weighting class estimates with no imputation estimates for T0141FA

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	Y-TOTAL	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TOTAL	1	15089	7039.68	-0.44	0.66	-0.15	-0.44	0.55	-0.15	1.08	1.37	1.00
SEX	1	7357	6623.30	0.02	0.70	0.09	0.01	0.48	0.06	1.39	1.60	1.44
SEX	2	7637	7460.24	-0.63	0.61	-0.39	-0.34	0.26	-0.21	1.96	2.38	1.90
APTITUDE	1	2945	7993.05	0.30	2.33	-0.53	0.14	0.83	-0.28	2.06	3.64	1.95
APTITUDE	2	4788	7574.10	0.74	0.28	0.25	0.67	0.22	0.24	1.33	1.26	1.04
APTITUDE	3	2839	5327.10	-0.14	1.07	0.37	-0.06	0.49	0.18	2.08	2.42	2.04
SES	1	4220	7662.68	-0.70	1.18	-0.64	-0.43	0.54	-0.40	1.77	2.48	1.72
SES	2	7207	7584.67	-0.47	0.49	-0.35	-0.43	0.40	-0.33	1.18	1.32	1.13
SES	3	3431	5345.91	0.52	0.45	1.04	0.25	0.15	0.50	2.11	2.90	2.30
RACE	1	1963	5945.80	-3.02	-0.62	-0.90	-1.03	-0.20	-0.34	4.21	3.15	2.78
RACE	2	11679	7139.01	-0.54	0.67	-0.15	-0.63	0.58	-0.17	1.01	1.33	0.91
RACE	3	91	8927.16	-4.01	-6.08	-8.71	-0.31	-0.56	-0.79	13.39	12.41	14.02
RACE	4	1231	7176.37	2.53	2.63	1.42	0.63	0.63	0.38	4.70	4.92	3.93
REGION	1	3051	6542.09	-1.50	-1.20	-0.62	-0.60	-0.43	-0.25	2.89	2.98	2.49
REGION	2	3948	7352.66	-0.79	0.80	-0.62	-0.70	0.50	-0.54	1.38	1.80	1.30
REGION	3	5551	7108.95	0.56	2.19	0.59	0.25	0.73	0.29	2.26	3.69	2.13
REGION	4	2539	7136.62	-0.04	0.34	0.00	-0.02	0.16	0.00	1.84	2.09	1.65
RACE BY ABILITY	1	822	6438.20	-4.11	-0.86	-2.44	-1.47	-0.22	-1.11	4.97	3.94	3.27
RACE BY ABILITY	2	357	5648.06	5.26	1.77	3.61	0.45	0.24	0.53	7.90	7.60	7.67
RACE BY ABILITY	4	1632	8578.43	-0.00	2.23	-1.21	-0.44	0.77	-0.71	1.99	3.64	2.08
RACE BY ABILITY	5	4076	7606.99	0.65	0.15	0.16	0.65	0.12	0.18	1.18	1.27	0.91
RACE BY ABILITY	6	2656	5380.18	-0.29	1.05	0.17	-0.16	0.57	0.09	1.88	2.13	1.83
RACE BY ABILITY	10	452	7731.16	9.84	7.04	6.55	1.06	0.84	0.79	13.52	10.90	10.54
RACE BY ABILITY	11	328	7705.03	0.94	1.05	-0.63	0.18	0.18	-0.12	5.15	5.70	4.92
RACE BY ABILITY	12	131	8900.86	0.11	0.72	-0.10	0.01	0.06	-0.01	10.85	11.88	10.73

Comparison of hot deck and weighting class estimates with no imputation estimates for TQ141FB

DOMAIN	DOMAIN LEVEL	SAMPLE SIZE	$\bar{Y}$-TRUE	NI RB%	HD RB%	WC RB%	NI BR	HD BR	WC BR	NI RVMSE%	HD RVMSE%	WC RVMSE%
TOTAL	1	15089	8704.41	-0.57	-0.29	-0.43	-0.66	-0.29	-0.50	1.04	1.02	0.95
SEX	1	7357	8214.18	0.09	0.26	0.07	0.07	0.19	0.06	1.27	1.40	1.26
SEX	2	7637	9217.43	-0.96	-0.80	-0.91	-0.74	-0.57	-0.72	1.61	1.60	1.55
APTITUDE	1	2945	9568.49	0.68	0.58	-0.61	0.36	0.25	-0.37	2.01	2.40	1.74
APTITUDE	2	4708	9141.06	0.22	0.00	-0.10	0.26	0.00	-0.12	0.89	0.88	0.85
APTITUDE	3	2839	7349.55	-0.41	0.53	-0.08	-0.26	0.33	-0.06	1.60	1.69	1.47
SES	1	4220	8966.56	-1.18	-0.67	-1.19	-0.75	-0.35	-0.76	1.95	2.03	1.95
SES	2	7207	9323.27	-0.22	-0.28	-0.28	-0.29	-0.25	-0.37	0.80	1.13	0.82
SES	3	3431	7272.53	-0.22	0.00	0.06	-0.13	0.00	0.04	1.76	1.81	1.70
RACE	1	1963	6989.67	-1.80	1.07	0.28	-0.61	0.27	0.11	3.43	4.06	2.59
RACE	2	11679	8909.43	-0.65	-0.30	-0.40	-0.78	-0.35	-0.48	1.06	0.92	0.92
RACE	3	91	10459.77	-0.40	-4.11	-3.42	-0.04	-0.42	-0.69	8.82	10.55	9.50
RACE	4	1231	8625.98	-0.32	-1.37	-1.30	-0.09	-0.41	-0.40	3.48	3.60	3.51
REGION	1	3051	8139.59	-1.43	-0.92	-0.49	-0.76	-0.34	-0.28	2.34	2.83	1.82
REGION	2	3948	9119.38	-0.30	-0.60	-0.37	-0.24	-0.42	-0.31	1.27	1.55	1.23
REGION	3	5551	8824.41	0.15	0.38	-0.13	0.11	0.25	-0.10	1.42	1.54	1.31
REGION	4	2539	8639.47	.18	-0.03	-0.99	-0.55	-0.01	-0.49	2.44	2.36	2.22
RACE BY ABILITY	1	822	7267.49	1.31	1.25	0.40	-0.36	0.28	0.13	3.80	4.55	3.01
RACE BY ABILITY	2	357	6901.88	-0.43	0.60	-0.01	-0.06	0.08	0.00	7.01	7.27	6.55
RACE BY ABILITY	4	1632	10433.94	0.93	1.20	-0.40	0.42	0.47	-0.21	2.38	2.99	1.88
RACE BY ABILITY	5	4076	9270.04	0.28	0.07	0.02	0.27	0.07	0.01	1.08	1.09	0.97
RACE BY ABILITY	6	2656	7447.64	-0.50	0.51	-0.22	-0.37	0.37	-0.17	1.42	1.47	1.28
RACE BY ABILITY	10	452	9219.89	0.66	-2.93	-1.35	0.12	-0.60	-0.27	5.56	5.67	5.08
RACE BY ABILITY	11	328	9291.40	0.27	-1.30	-1.72	0.06	-0.28	-0.42	4.28	4.71	4.44
RACE BY ABILITY	12	131	5901.71	0.78	0.91	0.86	0.08	0.08	0.09	9.71	10.50	9.60

Appendix J

COMPARISON OF VARIANCE ESTIMATORS

Glossary of Terms Used in the Tables

SAMPLE SIZE - number of sample members eligible to respond to a particular item for the domain under consideration.

$\bar{Y}$-TRUE - the estimate obtained using the telephone corrected and completed data.

STDERR SD - the standard deviation obtained when the STDERR Taylor Series linearization is used.

BRR SD - the standard deviation obtained using the Balanced Repeated Replication Technique.

SD RATIO - the ratio of the STDERR SD to the BRR SD.

NI - the no imputation estimates obtained using the experimental data set.

NIC - the no imputation estimates obtained using the experimental data set after inconsistent data were removed.

Comparison of variance estimators for discrete items for the total population

ITEM	RESPONSE	SAMPLE SIZE	P-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ1A	1	15089	72.29	0.44	0.41	1.08	0.45	0.45	0.99
TQ1C	1	15089	17.16	0.41	0.38	1.08	0.39	0.35	1.10
TQ1D	1	15089	4.12	0.22	0.17	1.26	0.22	0.20	1.08
TQ1G	1	15089	9.19	0.30	0.25	1.19	0.31	0.25	1.22
TQ9A	1	15089	67.82	0.51	0.50	1.02	0.51	0.59	0.87
TQ9C	1	15089	32.15	0.55	0.51	1.08	0.53	0.46	1.16
TQ9D	1	15089	3.96	0.20	0.18	1.08	0.18	0.17	1.08
TQ9G	1	15089	7.00	0.25	0.30	0.83	0.26	0.34	0.75
TQ10	1	15089	61.22	0.47	0.53	0.87	0.47	0.54	0.88
TQ10	2	15089	13.06	0.33	0.35	0.95	0.31	0.32	0.96
TQ10	3	15089	1.45	0.12	0.11	1.04	0.11	0.12	0.95
TQ10	4	15089	24.27	0.43	0.39	1.09	0.44	0.37	1.18
TQ12	1	3644	25.66	0.92	0.91	1.00	0.90	0.97	0.92
TQ12	2	3644	7.20	0.54	0.51	1.06	0.58	0.54	1.07
TQ12	3	3644	67.14	1.03	1.13	0.91	1.03	1.21	0.85
TQ29	1	11439	91.40	0.34	0.36	0.92	0.34	0.37	0.91
TQ29	2	11439	8.60	0.34	0.36	0.92	0.34	0.37	0.91
TQ33	1	4234	17.56	0.76	0.79	0.95	0.70	0.89	0.77
TQ33	2	4234	3.57	0.33	0.26	1.24	0.36	0.30	1.19
TQ33	3	4234	78.87	0.81	0.81	1.00	0.78	1.03	0.75
TQ51	1	15089	47.13	0.57	0.62	0.91	0.58	0.61	0.94
TQ51	2	15089	52.87	0.57	0.62	0.91	0.58	0.61	0.94
TQ52	1	7579	49.75	0.67	0.67	1.00	0.68	0.73	0.93
TQ52	2	7579	50.25	0.67	0.67	1.00	0.68	0.73	0.93
TQ66	1	7579	20.29	0.58	0.35	1.67	0.57	0.40	1.42
TQ66	2	7579	32.03	0.65	0.57	1.13	0.65	0.56	1.16
TQ66	3	7579	47.68	0.75	0.71	1.06	0.75	0.64	1.17
TQ90	1	7579	65.64	0.70	0.75	0.92	0.70	0.73	0.95
TQ90	2	7579	4.67	0.32	0.34	0.92	0.30	0.31	0.98
TQ90	3	7579	5.79	0.32	0.38	0.84	0.32	0.36	0.87
TQ90	4	7579	23.90	0.63	0.85	0.73	0.63	0.85	0.74
TQ101	1	15089	84.17	0.45	0.34	1.30	0.45	0.34	1.32
TQ101	2	15089	15.83	0.45	0.34	1.30	0.45	0.34	1.32
TQ102	1	2199	66.64	1.26	1.33	0.94	1.29	1.37	0.94
TQ102	2	2199	33.36	1.26	1.33	0.94	1.29	1.37	0.94
TQ118	1	15089	92.68	0.30	0.22	1.36	0.30	0.22	1.36
TQ118	2	15089	0.90	0.11	0.09	1.20	0.11	0.10	1.10
TQ118	3	15089	6.42	0.28	0.25	1.10	0.28	0.25	1.11
TQ129	1	15089	9.78	0.50	0.38	0.77	0.30	0.38	0.77
TQ129	2	15089	45.95	0.54	0.42	1.29	0.54	0.42	1.29
TQ129	3	15089	4.02	0.19	0.20	0.92	0.19	0.20	0.92
TQ129	4	15089	40.25	0.56	0.28	1.96	0.56	0.29	1.92
TQ131A	1	6336	73.00	0.69	0.67	1.02	0.69	0.68	1.00
TQ131C	1	6336	7.87	0.45	0.50	0.88	0.45	0.51	0.88
TQ131D	1	6336	4.30	0.31	0.50	0.62	0.31	0.50	0.63
TQ131F	1	6336	26.45	0.71	0.90	0.79	0.71	0.90	0.79
TQ136BOX	1	7010	18.19	0.57	0.63	0.91	0.57	0.63	0.91
TQ136A	1	5743	71.91	0.71	0.77	0.93	0.71	0.77	0.93
TQ136C	1	5743	9.09	0.44	0.52	0.85	0.44	0.52	0.85
TQ136D	1	5743	3.89	0.30	0.30	0.98	0.30	0.30	0.98
TQ136F	1	5743	21.81	0.70	0.76	0.91	0.70	0.76	0.91

Comparison of variance estimators for discrete items for males

ITEM	RESPONSE	SAMPLE SIZE	$\bar{Y}$-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ1A	1	7357	77.00	0.65	0.47	1.38	0.65	0.49	1.32
TQ1C	1	7357	19.84	0.59	0.63	0.93	0.57	0.51	1.11
TQ1D	1	7357	4.63	0.33	0.21	1.55	0.32	0.23	1.35
TQ1G	1	7357	9.28	0.47	0.50	0.94	0.49	0.52	0.92
TQ9A	1	7357	71.16	0.73	0.87	0.84	0.73	0.96	0.76
TQ9C	1	7357	35.17	0.77	0.80	0.96	0.77	0.82	0.94
TQ9D	1	7357	4.50	0.29	0.16	1.79	0.27	0.20	1.34
TQ9G	1	7357	7.12	0.35	0.39	0.90	0.37	0.44	0.84
TQ10	1	7357	68.57	0.65	0.50	1.30	0.66	0.49	1.35
TQ10	2	7357	11.75	0.43	0.51	0.85	0.40	0.45	0.88
TQ10	3	7357	1.39	0.17	0.19	0.90	0.17	0.20	0.86
TQ10	4	7357	18.28	0.59	0.46	1.26	0.60	0.50	1.20
TQ12	1	1295	36.19	1.69	1.58	1.06	1.71	1.49	1.14
TQ12	2	1295	6.90	0.86	0.58	1.48	0.92	0.61	1.49
TQ12	3	1295	56.83	1.77	1.72	1.03	1.79	1.72	1.03
TQ29	1	6058	90.26	0.47	0.32	1.48	0.47	0.34	1.39
TQ29	2	6058	9.74	0.47	0.32	1.48	0.47	0.34	1.39
TQ33	1	1633	21.65	1.29	1.10	1.17	1.23	1.12	1.09
TQ33	2	1633	3.90	0.55	0.62	0.88	0.59	0.53	1.09
TQ33	3	1633	74.45	1.39	1.27	1.09	1.35	1.30	1.04
TQ51	1	7357	43.76	0.74	0.83	0.88	0.74	0.80	0.92
TQ51	2	7357	56.24	0.74	0.83	0.88	0.74	0.80	0.92
TQ52	1	3970	45.84	0.90	0.96	0.94	0.94	1.06	0.88
TQ52	2	3970	54.16	0.90	0.96	0.94	0.94	1.06	0.88
TQ66	1	3970	18.94	0.77	0.48	1.58	0.76	0.52	1.46
TQ66	2	3970	35.38	0.97	0.86	1.11	0.97	1.03	0.94
TQ66	3	3970	45.68	0.98	1.05	0.93	1.03	1.06	0.96
TQ90	1	3970	66.03	0.91	0.74	1.23	0.92	0.72	1.26
TQ90	2	3970	8.64	0.45	0.60	0.75	0.44	0.54	0.81
TQ90	3	3970	5.22	0.41	0.51	0.81	0.41	0.45	0.92
TQ90	4	3970	24.11	0.87	0.79	1.09	0.88	0.78	1.12
TQ101	1	7357	84.87	0.63	0.66	0.95	0.63	0.65	0.96
TQ101	2	7357	15.13	0.63	0.66	0.95	0.63	0.65	0.96
TQ102	1	1031	61.36	1.94	2.23	0.86	1.98	2.45	0.81
TQ102	2	1031	38.64	1.94	2.23	0.86	1.98	2.45	0.81
TQ118	1	7357	87.00	0.54	0.37	1.46	0.54	0.37	1.45
TQ118	2	7357	1.56	0.20	0.20	1.02	0.20	0.19	1.02
TQ118	3	7357	11.44	0.51	0.45	1.12	0.51	0.45	1.11
TQ129	1	7357	9.93	0.46	0.52	0.88	0.46	0.52	0.88
TQ129	2	7357	54.44	0.82	0.93	0.87	0.82	0.93	0.88
TQ129	3	7357	2.82	0.22	0.19	1.15	0.22	0.19	1.15
TQ129	4	7357	32.81	0.75	0.66	1.12	0.75	0.67	1.11
TQ131A	1	2592	55.12	1.17	0.90	1.29	1.17	0.94	1.24
TQ131C	1	2592	7.41	0.64	0.64	1.00	0.65	0.65	0.99
TQ131D	1	2592	2.50	0.40	0.58	0.67	0.40	0.59	0.67
TQ131F	1	2592	62.05	1.15	0.89	1.28	1.15	0.93	1.23
TQ136BOX	1	2817	20.73	0.91	0.74	1.22	0.91	0.74	1.22
TQ136A	1	2231	54.83	1.26	1.10	1.15	1.26	1.10	1.14
TQ136C	1	2231	8.72	0.72	0.65	1.10	0.72	0.65	1.10
TQ136D	1	2231	2.32	0.40	0.43	0.91	0.40	0.43	0.91
TQ136F	1	2231	53.44	1.33	1.21	1.09	1.33	1.21	1.09

Comparison of variance estimators for discrete items for individuals of high ability

ITEM	RESPONSE	SAMPLE SIZE	P-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
T01A	1	2839	71.74	0.92	1.01	0.91	0.96	1.21	0.78
T01C	1	2839	26.28	0.97	0.92	1.05	0.96	0.70	1.36
T01D	1	2839	4.11	0.50	0.40	1.25	0.51	0.38	1.33
T01G	1	2839	8.38	0.59	0.47	1.23	0.60	0.47	1.25
T09A	1	2839	63.08	1.22	0.87	1.39	1.25	1.18	1.05
T09C	1	2839	58.79	1.25	1.10	1.13	1.33	1.02	1.29
T09D	1	2839	2.86	0.37	0.39	0.94	0.38	0.34	1.14
T09G	1	2839	4.91	0.41	0.47	0.88	0.47	0.57	0.81
T010	1	2839	53.65	1.01	1.17	0.85	1.0-	1.30	0.78
T010	2	2839	20.40	0.90	0.57	1.57	0.8?	0.52	1.62
T010	3	2839	1.26	0.26	0.26	0.97	0.?2	0.24	0.90
T010	4	2839	24.70	0.91	1.09	0.82	0.92	1.17	0.78
T012	1	732	22.03	1.97	1.69	1.16	1.95	1.73	1.12
T012	2	732	6.26	1.04	1.08	0.96	1.09	1.06	1.02
T012	3	732	71.72	2.18	1.95	1.11	2.15	2.26	0.95
T029	1	2107	89.82	0.79	0.70	1.13	0.79	0.70	1.12
T029	2	2107	10.18	0.79	0.70	1.13	0.79	0.70	1.12
T033	1	993	9.39	1.27	1.30	0.97	1.02	0.97	1.04
T033	2	993	2.35	0.50	0.35	1.44	0.51	0.34	1.49
T033	3	993	88.26	1.34	1.31	1.02	1.12	1.03	1.08
T051	1	2839	21.90	1.01	0.89	1.13	1.02	0.91	1.12
T051	2	2839	78.10	1.01	0.89	1.13	1.02	0.91	1.12
T052	1	2155	47.38	1.19	1.04	1.14	1.21	1.07	1.13
T052	2	2155	52.62	1.19	1.04	1.14	1.21	1.07	1.13
T066	1	2155	11.65	0.77	0.69	1.11	0.78	0.74	1.05
T066	2	2155	32.40	1.10	1.17	0.94	1.13	1.22	0.92
T066	3	2155	55.95	1.23	1.02	1.22	1.29	0.99	1.29
T090	1	2155	62.00	1.22	1.14	1.07	1.23	1.14	1.07
T090	2	2155	5.15	0.55	0.95	0.57	0.53	0.85	0.62
T090	3	2155	5.26	0.58	0.65	0.89	0.57	0.61	0.94
T090	4	2155	27.59	1.18	1.27	0.92	1.18	1.27	0.93
T0101	1	2839	64.32	1.27	1.32	0.95	1.27	1.33	0.95
T0101	2	2839	35.68	1.27	1.32	0.95	1.27	1.33	0.95
T0102	1	951	60.71	1.89	1.07	1.75	1.69	1.11	1.70
T0102	2	951	39.29	1.89	1.07	1.75	1.89	1.11	1.70
T0118	1	2839	94.43	0.53	0.40	1.32	0.53	0.39	1.37
T0118	2	2839	0.41	0.11	0.09	1.17	0.10	0.09	1.11
T0118	3	2839	5.17	0.53	0.38	1.37	0.53	0.39	1.36
T0129	1	2839	10.73	0.65	0.73	0.90	0.65	0.73	0.89
T0129	2	2839	58.04	1.17	1.04	1.12	1.17	1.04	1.12
T0129	3	2839	2.37	0.31	0.28	1.11	0.31	0.28	1.11
T0129	4	2839	28.86	1.04	0.95	1.09	1.04	0.95	1.09
T0131A	1	867	78.46	1.62	1.67	0.97	1.62	1.67	0.97
T0131C	1	867	12.63	1.39	1.30	1.06	1.39	1.30	1.06
T0131D	1	867	4.61	0.84	1.04	0.81	0.84	1.04	0.81
T0131F	1	867	22.94	1.80	2.56	0.70	1.80	2.56	0.70
T0136BOX	1	940	22.20	1.60	1.55	1.02	1.60	1.55	1.02
T0136A	1	731	72.05	2.02	2.45	0.82	2.02	2.45	0.82
T0136C	1	731	17.65	1.72	1.70	1.01	1.72	1.70	1.01
T0136D	1	731	4.05	0.85	1.09	0.78	0.85	1.09	0.78
T0136F	1	731	17.55	1.67	1.99	0.83	1.67	1.99	0.83

Comparison of variance estimators for discrete items for individuals of low socio-economic status

ITEM	RESPONSE	SAMPLE SIZE	Ȳ-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ1A	1	4220	69.91	0.94	0.83	1.13	0.95	0.83	1.14
TQ1C	1	4220	10.77	0.66	0.72	0.92	0.53	0.57	0.94
TQ1D	1	4220	3.84	0.39	0.33	1.17	0.34	0.28	1.18
TQ1G	1	4220	11.47	0.65	0.50	1.28	0.67	0.53	1.26
TQ9A	1	4220	68.85	0.92	0.92	1.00	0.95	0.87	1.08
TQ9C	1	4220	16.26	0.74	1.02	0.72	0.71	0.76	0.93
TQ9D	1	4220	3.66	0.36	0.27	1.33	0.33	0.23	1.43
TQ9G	1	4220	10.13	0.60	0.73	0.81	0.57	0.63	0.90
TQ10	1	4220	62.88	0.90	0.83	1.08	0.93	0.85	1.09
TQ10	2	4220	9.10	0.50	0.40	1.24	0.48	0.35	1.37
TQ10	3	4220	1.93	0.29	0.22	1.28	0.28	0.20	1.41
TQ10	4	4220	26.09	0.92	0.80	1.14	0.95	0.80	1.18
TQ12	1	1069	30.32	1.84	1.07	1.71	1.88	1.08	1.74
TQ12	2	1069	7.30	0.89	0.83	1.07	0.96	0.87	1.10
TQ12	3	1069	62.39	1.90	1.24	1.52	1.92	1.23	1.56
TQ29	1	3150	91.46	0.60	0.50	1.21	0.60	0.50	1.19
TQ29	2	3150	8.54	0.60	0.50	1.21	0.60	0.50	1.19
TQ33	1	1099	26.92	1.59	0.93	1.70	1.48	1.26	1.17
TQ33	2	1099	3.71	0.68	0.42	1.63	0.72	0.59	1.21
TQ33	3	1099	69.38	1.64	1.02	1.59	1.59	1.61	0.98
TQ51	1	4220	64.83	1.00	1.02	0.97	1.02	1.06	0.95
TQ51	2	4220	35.17	1.00	1.02	0.97	1.02	1.06	0.95
TQ52	1	1420	49.78	1.64	1.80	0.91	1.67	1.82	0.91
TQ52	2	1420	50.22	1.64	1.80	0.91	1.67	1.82	0.91
TQ66	1	1420	30.72	1.54	1.48	1.03	1.58	1.53	1.03
TQ66	2	1420	29.91	1.59	1.43	1.11	1.58	1.32	1.19
TQ66	3	1420	39.37	1.59	1.59	1.00	1.64	1.50	1.09
TQ90	1	1420	52.38	1.69	2.31	0.72	1.70	2.35	0.72
TQ90	2	1420	6.44	0.84	0.77	1.08	0.82	0.79	1.04
TQ90	3	1420	8.32	0.90	0.52	1.73	0.90	0.63	1.42
TQ90	4	1420	32.86	1.58	1.92	0.82	1.60	1.91	0.83
TQ101	1	4220	94.03	0.50	0.53	0.93	0.50	0.53	0.93
TQ101	2	4220	5.97	0.50	0.53	0.93	0.50	0.53	0.93
TQ102	1	230	67.12	3.95	4.89	0.80	3.98	4.85	0.81
TQ102	2	230	32.88	3.95	4.89	0.80	3.98	4.85	0.81
TQ118	1	4220	90.23	0.63	0.56	1.13	0.63	0.56	1.13
TQ118	2	4220	1.43	0.32	0.28	1.16	0.32	0.28	1.16
TQ118	3	4220	0.33	0.55	0.60	0.91	0.55	0.60	0.91
TQ129	1	4220	9.35	0.52	0.68	0.76	0.52	0.68	0.76
TQ129	2	4220	35.96	0.92	0.79	1.16	0.92	0.80	1.14
TQ129	3	4220	6.12	0.47	0.55	0.85	0.47	0.55	0.85
TQ129	4	4220	48.57	0.87	0.75	1.15	0.87	0.74	1.17
TQ131A	1	2093	71.01	1.23	1.45	0.84	1.23	1.47	0.83
TQ131C	1	2093	5.12	0.68	0.79	0.85	0.68	0.80	0.85
TQ131D	1	2093	3.97	0.52	0.47	1.10	0.52	0.47	1.10
TQ131F	1	2093	26.91	1.28	1.37	0.93	1.29	1.36	0.94
TQ136BOX	1	2354	14.14	0.91	0.99	0.92	0.91	0.99	0.92
TQ136A	1	2021	71.81	1.24	1.14	1.08	1.24	1.15	1.08
TQ136C	1	2021	5.72	0.65	0.58	1.11	0.65	0.58	1.11
TQ136D	1	2021	3.65	0.46	0.37	1.25	0.46	0.37	1.25
TQ136F	1	2021	21.46	1.12	1.12	1.00	1.12	1.10	1.01

Comparison of variance estimators for discrete items for blacks

ITEM	RESPONSE	SAMPLE SIZE	Y-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ1A	1	1963	69.37	1.33	1.38	0.96	1.36	1.39	0.97
TQ1C	1	1963	17.03	1.12	0.87	1.29	1.07	0.88	1.20
TQ1D	1	1963	5.51	0.56	0.67	0.83	0.53	0.47	1.14
TQ1G	1	1963	14.45	1.07	1.16	0.91	1.14	1.25	0.90
TQ9A	1	1963	64.93	1.35	1.35	1.00	1.48	1.27	1.16
TQ9C	1	1963	26.71	1.22	1.78	0.68	1.24	1.29	0.95
TQ9D	1	1963	6.83	0.75	0.69	1.08	0.70	0.81	0.85
TQ9G	1	1963	13.81	0.80	1.05	0.75	0.87	1.07	0.81
TQ10	1	1963	59.55	1.38	1.24	1.11	1.39	1.41	0.98
TQ10	2	1963	12.36	0.92	0.71	1.29	0.89	0.57	1.54
TQ10	3	1963	1.85	0.44	0.53	0.82	0.45	0.58	0.77
TQ10	4	1963	26.24	1.31	1.18	1.10	1.34	1.27	1.05
TQ12	1	505	38.87	3.15	2.77	1.12	3.23	2.78	1.16
TQ12	2	505	12.45	1.79	2.00	0.89	1.99	2.28	0.87
TQ12	3	505	48.68	3.04	2.65	1.14	3.19	2.63	1.21
TQ29	1	1455	92.03	0.84	0.81	1.03	0.84	0.81	1.02
TQ29	2	1455	7.97	0.84	0.81	1.03	0.84	0.81	1.02
TQ33	1	569	37.85	2.42	1.90	1.27	2.28	1.88	1.21
TQ33	2	569	5.80	1.52	1.47	1.03	1.26	0.96	1.31
TQ33	3	569	56.35	2.49	1.72	1.44	2.38	1.85	1.28
TQ51	1	1963	50.21	1.54	1.64	0.93	1.56	1.65	0.94
TQ51	2	1963	49.79	1.54	1.64	0.93	1.56	1.65	0.94
TQ52	1	928	44.94	2.00	1.92	1.04	2.05	2.21	0.92
TQ52	2	928	55.06	2.00	1.92	1.04	2.05	2.21	0.92
TQ66	1	928	23.08	1.88	1.76	1.07	1.76	1.82	0.96
TQ66	2	928	35.77	1.89	1.96	0.96	1.95	1.85	1.05
TQ66	3	928	41.15	1.85	1.62	1.14	1.88	1.65	1.14
TQ90	1	928	42.92	2.11	1.87	1.12	2.17	2.10	1.03
TQ90	2	928	6.37	1.17	1.34	0.87	0.89	0.91	0.97
TQ90	3	928	10.97	1.23	1.32	0.93	1.24	1.43	0.87
TQ90	4	928	39.75	2.05	2.65	0.77	2.06	2.47	0.83
TQ101	1	1963	90.16	0.84	1.00	0.84	0.85	1.01	0.84
TQ101	2	1963	9.84	0.84	1.00	0.84	0.85	1.01	0.84
TQ102	1	180	64.15	3.99	3.98	1.00	4.16	4.64	0.89
TQ102	2	180	35.85	3.99	3.98	1.00	4.16	4.64	0.89
TQ118	1	1963	89.04	1.06	0.96	1.10	1.06	0.95	1.10
TQ118	2	1963	1.24	0.34	0.35	0.97	0.34	0.35	0.97
TQ118	3	1963	9.72	1.01	0.91	1.10	1.00	0.90	1.11
TQ129	1	1963	12.11	0.90	1.06	0.84	0.90	1.04	0.87
TQ129	2	1963	51.15	1.47	1.17	1.25	1.46	1.15	1.26
TQ129	3	1963	4.24	0.51	0.49	1.03	0.51	0.49	1.02
TQ129	4	1963	32.50	1.53	1.38	1.10	1.54	1.38	1.11
TQ131A	1	644	73.54	2.32	2.85	0.81	2.34	2.79	0.83
TQ131C	1	644	6.67	1.27	1.12	1.13	1.28	1.13	1.13
TQ131D	1	644	4.02	0.96	1.03	0.93	0.97	1.03	0.93
TQ131F	1	644	3.42	2.17	2.49	0.88	2.19	2.37	0.92
TQ136BOX	1	745	17.27	1.76	1.16	1.51	1.76	1.16	1.51
TQ136A	1	615	73.44	1.98	1.63	1.21	1.99	1.63	1.22
TQ136C	1	615	8.54	1.22	1.22	1.00	1.23	1.22	1.00
TQ136D	1	615	4.78	1.05	0.88	1.19	1.05	0.89	1.18
TQ136F	1	615	18.05	1.88	1.64	1.14	1.90	1.59	1.19

Comparison of variance estimators for discrete items for the South

ITEM	RESPONSE	SAMPLE SIZE	$\bar{Y}$-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ1A	1	3948	73.45	0.89	0.67	1.31	0.86	0.60	1.43
TQ1C	1	3948	17.20	0.82	0.90	0.90	0.72	0.88	0.80
TQ1D	1	3948	4.21	0.38	0.33	1.15	0.38	0.40	0.96
TQ1G	1	3948	8.07	0.43	0.41	1.02	0.43	0.51	0.84
TQ9A	1	3948	68.68	0.90	0.57	1.58	0.83	0.48	1.70
TQ9C	1	3948	30.59	0.99	0.90	1.10	0.93	0.85	1.10
TQ9D	1	3948	4.04	0.35	0.31	1.10	0.31	0.26	1.19
TQ9G	1	3948	7.28	0.46	0.26	1.76	0.50	0.36	1.39
TQ10	1	3943	61.38	0.88	0.56	1.58	0.88	0.65	1.35
TQ10	2	3948	14.20	0.63	0.59	1.06	0.57	0.58	0.98
TQ10	3	3948	1.35	0.20	0.14	1.47	0.18	0.16	1.13
TQ10	4	3948	23.07	0.81	0.59	1.38	0.84	0.58	1.45
TQ12	1	908	22.91	1.69	1.55	1.08	1.65	1.93	0.85
TQ12	2	908	7.94	1.06	0.82	1.30	1.13	0.93	1.21
TQ12	3	>08	69.16	1.88	1.58	1.19	1.85	1.69	1.09
TQ29	1	3039	90.75	0.67	0.67	0.98	0.66	0.69	0.95
TQ29	2	3039	9.25	0.67	0.67	0.98	0.66	0.69	0.95
TQ33	1	1088	18.26	1.50	1.59	0.94	1.42	1.30	1.08
TQ33	2	1088	3.66	0.61	0.32	1.92	0.62	0.43	1.43
TQ33	3	1088	78.09	1.55	1.61	0.96	1.51	1.21	1.25
TQ51	1	3948	48.96	1.01	1.02	0.99	1.03	1.03	0.99
TQ51	2	3948	51.04	1.01	1.02	0.99	1.03	1.03	0.99
TQ52	1	1922	47.56	1.27	1.52	0.83	1.29	1.74	0.74
TQ52	2	1922	52.44	1.27	1.52	0.83	1.29	1.74	0.74
TQ66	1	1922	18.95	1.04	0.79	1.31	1.06	0.87	1.21
TQ66	2	1922	35.69	1.42	1.57	0.90	1.44	1.78	0.80
TQ66	3	1922	45.36	1.54	1.71	0.90	1.56	1.69	0.92
TQ90	1	1922	65.01	1.37	1.43	0.95	1.37	1.43	0.95
TQ90	2	1922	4.02	0.46	0.63	0.72	0.47	0.64	0.72
TQ90	3	1922	6.96	0.71	0.61	1.15	0.70	0.56	1.25
TQ90	4	1922	24.00	1.21	1.50	0.80	1.22	1.41	0.86
TQ101	1	3948	85.24	0.83	0.78	1.06	0.83	0.77	1.07
TQ101	2	3948	14.76	0.83	0.78	1.06	0.83	0.77	1.07
TQ102	1	549	66.41	2.27	3.05	0.74	2.27	2.94	0.77
TQ102	2	549	33.59	2.27	3.05	0.74	2.27	2.94	0.77
TQ118	1	3948	93.04	0.55	0.65	0.85	0.55	0.65	0.85
TQ118	2	3948	1.00	0.21	0.26	0.82	0.21	0.26	0.82
TQ110	3	3948	5.96	0.48	0.47	1.02	0.48	0.47	1.02
TQ129	1	3948	9.85	0.55	0.56	0.98	0.55	0.57	0.97
TQ129	2	3948	43.62	1.00	0.96	1.04	1.01	0.96	1.04
TQ129	3	3948	3.54	0.29	0.26	1.13	0.29	0.25	1.17
TQ129	4	3948	42.99	1.04	0.90	1.15	1.04	0.90	1.15
TQ131A	1	1712	73.95	1.19	1.12	1.06	1.19	1.15	1.03
TQ131C	1	1712	7.72	0.79	0.86	0.92	0.80	0.86	0.92
TQ131D	1	1712	4.71	0.65	1.16	0.56	0.65	1.16	0.56
TQ131F	1	1712	26.23	1.31	1.32	0.99	1.32	1.33	0.98
TQ136BOX	1	1860	18.56	1.08	0.95	1.13	1.08	0.95	1.13
TQ136A	1	1518	72.70	1.29	1.72	0.75	1.29	1.72	0.75
TQ136C	1	1518	9.69	0.80	0.99	0.80	0.80	0.99	0.80
TQ136D	1	1518	4.30	0.63	0.49	1.28	0.63	0.49	1.28
TQ136F	1	1518	21.54	1.10	1.20	0.91	1.10	1.20	0.91

Comparison of variance estimators for discrete items for blacks of average ability

ITEM	RESPONSE	SAMPLE SIZE	$\bar{Y}$-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ1A	1	357	66.74	3.01	3.63	0.82	3.04	2.92	1.04
TQ1C	1	357	25.28	2.96	3.28	0.90	2.98	3.39	0.87
TQ1D	1	357	4.54	1.20	1.10	1.09	1.14	1.00	1.14
TQ1G	1	357	15.60	1.91	1.93	0.98	2.03	2.31	0.88
TQ9A	1	357	64.72	3.04	3.37	0.90	3.41	3.79	0.89
TQ9C	1	357	42.83	2.90	2.78	1.04	3.15	2.67	1.17
TQ9D	1	357	7.38	1.52	1.14	1.34	1.56	1.28	1.21
TQ9G	1	357	11.23	1.33	1.25	1.06	1.46	1.29	1.12
TQ10	1	357	56.17	3.23	3.31	0.97	3.18	3.34	0.95
TQ10	2	357	13.08	2.12	2.56	0.82	2.04	2.66	0.76
TQ10	3	357	2.73	1.24	1.49	0.83	1.29	1.55	0.83
TQ10	4	357	28.03	2.83	2.53	1.11	2.90	2.76	1.05
TQ12	1	101	37.05	6.33	7.50	0.84	5.89	6.56	0.89
TQ12	2	101	7.38	3.48	4.16	0.83	3.98	4.76	0.83
TQ12	3	101	55.57	6.68	7.49	0.89	6.71	7.12	0.94
TQ29	1	255	92.75	1.80	1.69	1.06	1.82	1.72	1.05
TQ29	2	255	7.25	1.80	1.69	1.06	1.82	1.72	1.05
TQ33	1	107	32.20	5.09	5.98	0.85	4.12	3.95	1.04
TQ33	2	107	4.28	1.97	3.09	0.63	2.33	3.66	0.63
TQ33	3	107	63.52	5.24	5.26	0.99	4.57	4.14	1.10
TQ51	1	357	30.74	2.83	3.57	0.79	2.82	3.61	0.77
TQ51	2	357	69.26	2.83	3.57	0.79	2.82	3.61	0.77
TQ52	1	233	49.04	3.81	3.19	1.19	3.32	3.68	1.06
TQ52	2	233	50.96	3.81	3.19	1.19	3.92	3.68	1.06
TQ66	1	233	20.16	3.39	3.76	0.90	3.47	3.83	0.90
TQ66	2	233	32.48	3.59	4.89	0.73	3.64	4.99	0.72
TQ66	3	233	47.36	3.74	2.97	1.25	3.90	3.30	1.18
TQ90	1	233	37.64	3.78	3.17	1.19	3.87	3.02	1.27
TQ90	2	233	7.49	2.21	1.20	1.84	2.19	1.34	1.64
TQ90	3	233	10.63	2.16	2.05	1.05	2.03	2.08	0.97
TQ90	4	233	44.25	3.84	3.12	1.22	3.90	3.28	1.18
TQ101	1	357	80.90	2.65	3.61	0.73	2.65	3.61	0.73
TQ101	2	357	19.10	2.65	3.61	0.73	2.65	3.61	0.73
TQ102	1	61	61.07	7.69	9.28	0.82	7.69	9.28	0.82
TQ102	2	61	38.93	7.69	9.28	0.82	7.69	9.28	0.82
TQ118	1	357	87.57	1.91	1.91	1.00	1.91	1.91	1.00
TQ118	2	357	0.23	0.19	0.20	0.94	0.19	0.20	0.94
TQ118	3	357	12.21	1.89	1.78	1.06	1.89	1.78	1.06
TQ129	1	357	8.69	1.76	1.77	0.99	1.77	1.77	1.00
TQ129	2	357	59.08	2.99	2.81	1.06	3.01	2.82	1.06
TQ129	3	357	5.21	1.28	1.31	0.97	1.29	1.31	0.98
TQ129	4	357	27.02	2.76	2.27	1.21	2.78	2.32	1.20
TQ131A	1	103	71.73	5.21	6.06	0.86	5.21	6.06	0.86
TQ131C	1	103	7.64	2.93	3.45	0.84	2.93	3.45	0.84
TQ131D	1	103	0.30	0.30	0.30	1.00	0.30	0.30	1.00
TQ131F	1	103	22.48	4.98	4.49	1.10	4.98	4.49	1.10
TQ136BOX	1	124	18.65	4.08	3.92	1.03	4.08	3.92	1.03
TQ136A	1	101	67.13	5.53	3.22	1.71	5.53	3.22	1.71
TQ136C	1	101	11.10	3.12	2.81	1.10	3.12	2.81	1.10
TQ136D	1	101	7.21	3.62	3.81	0.95	3.62	3.81	0.95
TQ136F	1	101	15.80	3.82	3.63	1.05	3.82	3.63	1.05

Comparison of variance estimators for continuous items for the total population

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ15	11445	38.75	0.13	0.13	1.03	0.13	0.13	1.00
TQ16	11445	160.26	1.13	0.99	1.14	1.12	1.00	1.12
TQ89HA	7579	2102.30	27.34	28.71	0.95	26.32	27.87	0.94
TQ89HB	7579	2173.09	34.57	34.52	1.00	28.31	28.08	1.00
TQ141FA	15089	7039.68	68.72	69.64	0.98	67.80	72.00	0.94
TQ141FB	15089	8704.41	73.70	75.88	0.97	73.04	68.48	1.06

Comparison of variance estimators for continuous items for males

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ15	6062	91.04	0.18	0.19	0.93	0.18	0.19	0.92
TQ16	6062	183.64	1.74	1.65	1.05	1.72	1.72	1.00
TQ89HA	3970	2182.70	39.29	42.50	0.92	37.05	34.33	1.07
TQ89HB	3970	2304.58	53.82	53.83	0.99	40.51	29.30	1.38
TQ191FA	7357	6623.30	81.22	92.31	0.87	76.99	92.90	0.82
TQ191FB	7357	8214.18	94.81	104.20	0.90	92.19	106.16	0.86

Comparison of variance estimators for continuous items for individuals of high ability

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ15	2107	36.26	0.33	0.31	1.06	0.33	0.31	1.06
TQ16	2107	148.26	2.08	1.85	1.12	2.08	1.93	1.07
TQ89HA	2155	2597.94	48.59	49.95	0.97	44.09	31.33	1.40
TQ89HB	2155	2698.50	55.71	55.99	0.99	52.27	39.63	1.31
TQ141FA	2839	5327.10	115.54	110.92	1.04	116.15	107.98	1.07
TQ141FB	2839	7349.55	132.45	114.10	1.16	128.94	112.81	1.14

Comparison of variance estimators for continuous items for individuals of low socio-economic status

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ15	3151	39.46	0.21	0.12	1.75	0.21	0.12	1.68
TQ16	3151	156.54	2.15	2.18	0.98	2.15	2.26	0.94
TQ89HA	1420	1638.01	64.21	53.59	1.19	61.34	35.71	1.71
TQ89HB	1420	1732.64	77.27	65.25	1.18	68.02	51.75	1.31
TQ141FA	4220	7662.68	118.17	125.03	0.94	114.28	102.80	1.11
TQ141FB	4220	8966.36	124.49	139.54	0.89	124.95	122.96	1.01

Comparison of variance estimators for continuous items for blacks

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ15	3040	39.06	0.27	0.23	1.16	0.27	0.26	1.04
TQ16	3040	162.99	1.89	1.80	1.05	1.92	1.94	0.98
TQ89HA	1922	2127.80	47.39	39.32	1.20	49.32	43.08	1.14
TQ89HB	1922	2196.52	53.19	58.81	0.90	50.89	53.64	0.94
TQ141FA	3948	7352.66	130.70	83.52	1.56	127.61	91.01	1.40
TQ141FB	3948	9119.38	136.50	112.58	1.21	134.12	105.22	1.27

271

Comparison of variance estimators for continuous items for the South

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ15	1458	37.68	0.33	0.28	1.16	0.33	0.27	1.18
TQ16	1458	145.73	3.07	3.81	0.00	3.11	3.80	0.81
TQ89HA	928	1702.03	90.46	81.27	1.11	78.07	69.57	1.12
TQ89HB	928	1774.33	113.24	110.43	1.02	86.44	64.69	1.33
TQ141FA	1963	5945.88	171.42	174.50	0.98	176.43	191.74	0.92
TQ141FB	1963	6989.57	196.03	204.20	0.96	203.59	222.65	0.91

Comparison of variance estimators for continuous items for blacks of average ability

ITEM	SAMPLE SIZE	$\bar{Y}$-TRUE	NI STDERR SD	NI BRR SD	NI SD RATIO	NIC STDERR SD	NIC BRR SD	NIC SD RATIO
TQ15	256	37.11	0.69	0.73	0.93	0.70	0.75	0.94
TQ16	256	162.89	11.22	12.86	0.87	11.37	13.21	0.86
TQ89HA	233	1890.48	142.68	116.93	1.22	149.32	133.79	1.11
TQ89HB	233	1974.43	150.04	143.32	1.04	158.64	153.65	1.03
TQ141FA	357	5648.06	376.67	406.61	0.92	374.58	420.10	0.89
TQ141FB	357	6901.88	414.62	483.29	0.85	419.68	485.84	0.86